The NATIONAL GEOGRAPHIC MAGAZINE

Vol. XX APRIL, 1909 No. 4

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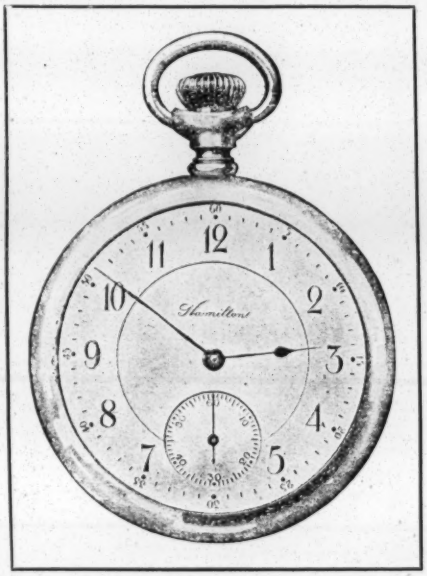

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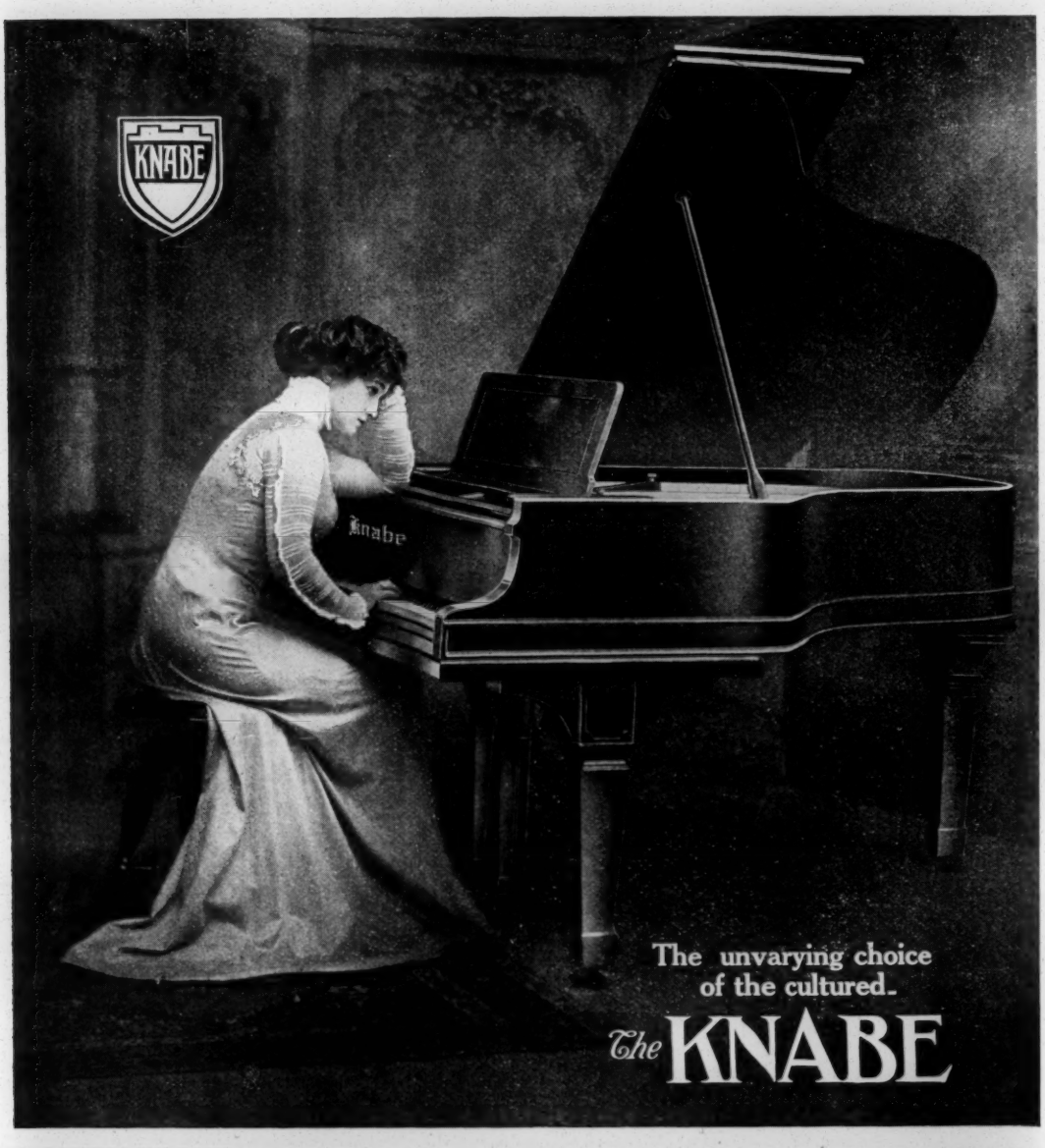

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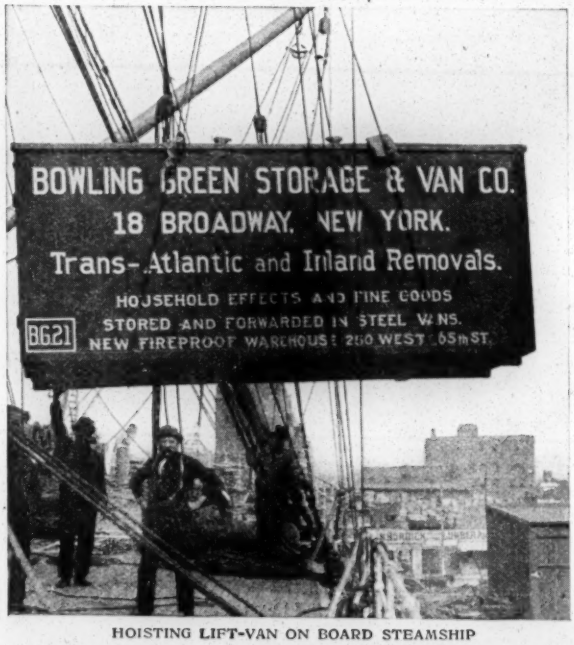
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VOL. XX, NO. 4 WASHINGTON APRIL, 1909

THE NATIONAL GEOGRAPHIC MAGAZINE

HUNTING THE GREAT BROWN BEAR OF ALASKA

BY GEORGE MIXTER, 2D, OF BOSTON

With Photographs by the Author

ON April 8, 1908, my brother, Dr C. G. Mixter, Mr C. R. Cross, Jr., and I left Seattle for Alaska with but a hazy idea of where we were going or what we would find when we got there. We knew that there was a place called Portage Bay on the Pacific coast of the Alaska Peninsula, where there was a small empty shack, and that opposite to it, on the Bering Sea coast, were Herendeen Bay and Port Moller Bay, on the former of which was a coal mine and a camp where the care-taker lived, in company with three horses; this was the region where we expected to find the Great Brown Bear of Alaska, the *Ursus gyas*.

We hoped—for by this time definite knowledge ended—that we would be able to get to the Coal Camp from Portage Bay, where we were to land, secure the use of the horses, transport our outfit to the other coast, and find some men there who knew the country and would go with us as guides. We had already telegraphed to Seward, Alaska, a town some 400 miles east of Portage Bay, engaging a certain Alfred Lowell, who had the reputation of being an excellent hunter and a strong packer, but who, of course, knew nothing of the country where we intended to hunt.

We spent seven days on the steamer *Yucatan*, following the coast back of Vancouver Island, through Seymour Narrows, and then, by the outside passage, straight to Cordova, Alaska, the terminus of the Copper River Railway, which is being built to form an outlet for the rich Copper River region. From here we followed a coast of extreme grandeur to Valdez and Seward, where we landed on the 15th. Seward, like Cordova, was a railway terminal and grew to a large town, but the Alaska Central Railroad was abandoned after penetrating 56 miles inland, and Seward is now nearly a dead town, with half of its houses deserted.

We found Alfred, and the next day the four of us started westward on the steamer *Dora*, a small and unsteady but very seaworthy craft. This part of the journey took us past Kodiak Island, near the middle of which we left the last trees we were to see until our return. To the westward there is nothing larger than alder bushes and scrub willows, which, by the way, will not burn in the open,

but have to be burned in a stove, which we found later to be the most important item in our camp outfit. As we got farther west the scenery grew more and more splendid, but the weather became steadily worse, wind and snow or sleet becoming the rule. Our most interesting point of call beyond Kodiak was Chignik, where there is one of the largest salmon canneries in that region, and where the rocks and snow mountains are particularly fine.

On April 27 we landed at Portage Bay in a blinding blizzard, and settled ourselves in the shack. We had already decided that, even if we could get them, the horses could not pack over the divide through the six or eight feet of snow, so we were rather at our wit's end to know how to get our outfit across. When the weather moderated, Cross and Alfred left us and started to find the Coal Camp, where they arrived after covering a very bad 16 miles.

By good luck they found at the camp a white man named Johnson with a team of four "outside dogs" (so called in contrast to the native dog, and which were in this case part setter and part "just dog," and made excellent pullers), so as soon as Cross, who had gone wholly snow-blind after the trip over the divide, was able to see well enough to take care of himself, Alfred and Johnson left him and came back to us with the dog-team. We were thus able to get our outfit, including a 15-foot cedar canoe, to the Coal Camp after three or four days of good hard work.

Before leaving the United States we had bought of the principal owners of the Herendeen Bay Coal Company the rights to a salmon boat, salvaged the previous year near the mouth of the Herendeen Bay, where there is a station for catching and salting salmon.

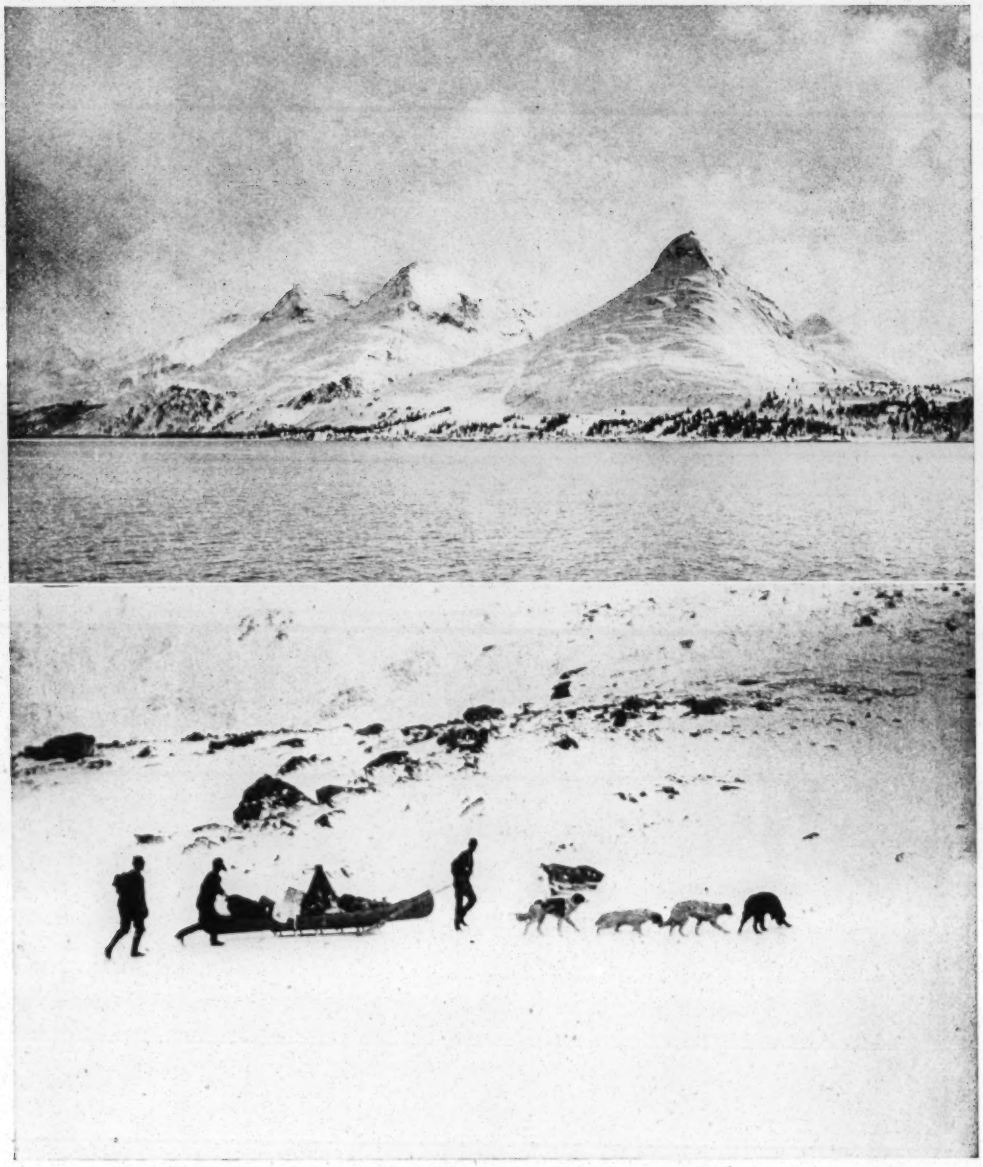
The next thing to do was to get our boat, but this was impossible for the present, as there were still 22 inches of ice in Herendeen Bay, and it was not until the 23d of May that we started for our real hunting grounds on Port Moller, and before that time we were fortunate enough to find two men whom we engaged to go with us. One of them, Mike Munson, a Swede, was a trapper, and the other, Andrew, an Aleut native, came as cook. It turned out that Mike knew but little and Andrew nothing at all about the country, but both proved excellent fellows and willing workers. Andrew was from a small Indian village on the Bering Sea coast at the mouth of Bear River, the largest stream we found, which was composed of perhaps 20 "barabaras" or native houses.

The Indians are all Greek Catholics (due to the former Russian control of the country), and are clean, though rather lazy. There are also a few Eskimo who have drifted down from Cape Nome, the southern boundary of their original district, and these are far more industrious than the native Aleuts. We found a small band of them camped at a hot sulphur spring near the shore of Port Moller.

We gradually became accustomed to the sudden heavy wind squalls (known as wooleys) and the incessant rain, which are the rule during May and the first half of June, and soon learned to pitch our tents in the middle of a thick clump of alders and to build wind-breaks around them. Nor did it take long to find a way to arrange our belongings indoors to give plenty of room near the stove for drying racks of alder sticks. It was very early on the trip, too, that we learned the inflammability of the paraffined silk of which our main tent was made, for a defective asbestos ring around the stovepipe set fire to the cloth, so that at least a third of it burned before we could extinguish it.

After this accident we used what was left of the old tent, and added to it an extension about seven feet long, which we christened the portico. The old part, now about nine feet square, we used for a sleeping-room, and put our stove, drying racks, etc., in the portico, which we made from the canvas tarpaulins from our blanket-rolls.

At this work Mike was invaluable, as he had been a sailor and was quite at



MOUNTAIN PEAKS NEAR VALDEZ: THE PHOTOGRAPH WAS TAKEN FROM THE STEAMER

TEAM OF SETTER DOGS AND THEIR WHITE OWNER WITH A LOAD OF OUR DUNNAGE, INCLUDING A SMALL CEDAR CANOE, ON HEIGHT OF DIVIDE BETWEEN THE PACIFIC AND THE BERING SEA

The pass is about 9 miles long from water to water

THREE SCOWS FULL OF SALMON FOR THE CANNERY AT CHIGNIK

LANDING A CALF FROM THE STEAMER AT KODIAK

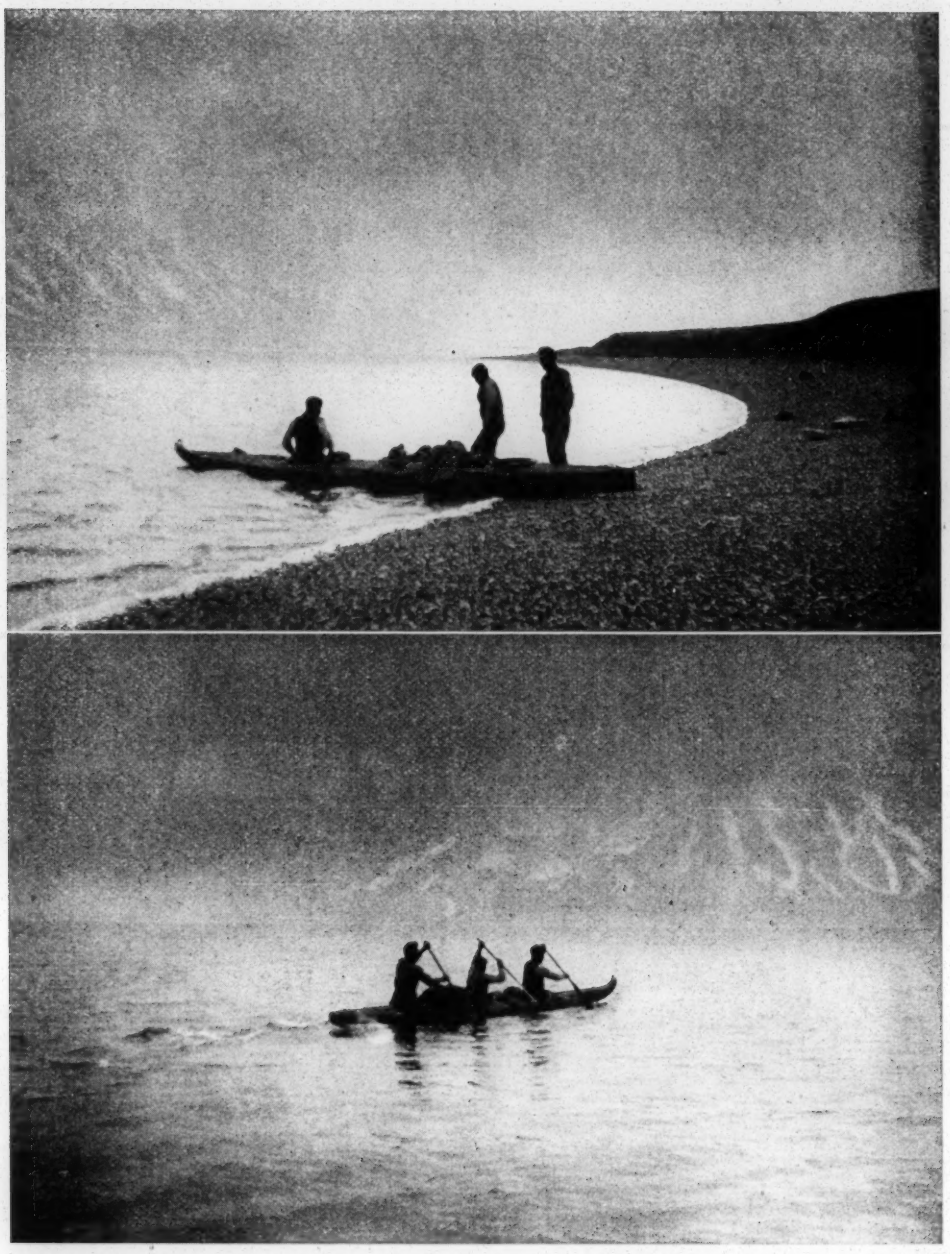
GROUP OF ESKIMO

AN ESKIMO AND THREE OF HIS CHILDREN

A THREE-HATCH "BIDARKI" OR "KYAK" (NATIVE SKIN CANOE)

These sea-worthy craft are made of sea-lion or hair seal skins, stretched and sewed with sinew over a frame of alder. The natives had just been out to get some of the first of the run of king salmon, one of which is lying on top of the bidarki.

FOUR ALEUT INDIANS GETTING READY TO GO OUT IN A THREE-HATCH NATIVE SKIN CANOE



THE SAME AFTER TWO HAVE GOT ABOARD

THE FOUR UNDER WAY: THE FOURTH MAN IS LYING ON HIS BACK ON THE BOTTOM, OUT OF SIGHT UNDER THE DECK

INDIAN WOMAN AND CHILD AT DOOR OF "BARABARA" OR SOD HUT

The part seen in the picture is only an enclosed passage leading to the main hut, which is out of sight on the left. The village consists of ten or fifteen of these barabaras, in which live 50 or 60 men, women, and children, while unnumbered dogs wander around outdoors.

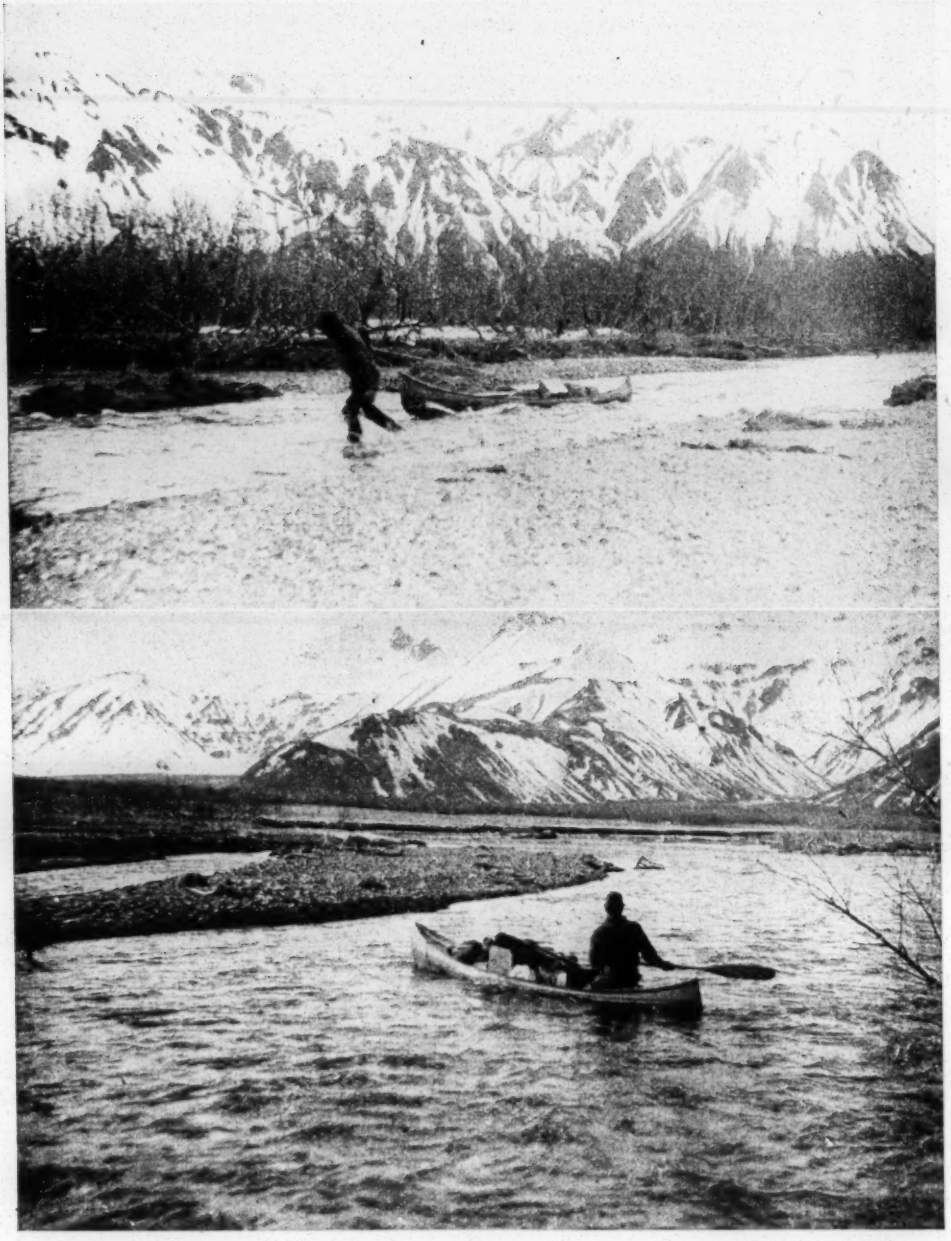
AN ESKIMO AND TWO OF HIS DOGS

TYPE OF HALF-BREEDS SEEN ON THE STEAMER

Their mother was a Siwash Indian and their father a light-haired Swede. The children are dark, with blue eyes and bright red hair.

THE SAME WOMAN AS SEEN ON PRECEDING PAGE

The young hopeful did not like to be "taken," so only an arm and a leg show around his mother's fur skirt



LINING THE CANOE UP-STREAM FROM THE BOAT ON THE SHORE TO THE CAMP

The streams are very shallow and swift, and so full of rocks that this was the only way to get the canoe up-stream

RUNNING LOADED CANOE DOWN-STREAM AFTER BREAKING CAMP

STARTING OFF ON A 40-MILE TRIP TO THE INDIAN VILLAGE AT THE MOUTH OF BEAR RIVER

The meat supply for the camp is seen hanging up in the background

BEAR LAKE PASS LOOKING TOWARD BEAR LAKE VALLEY

This pass extends from Port Moller Bay to Bear Lake Valley, a distance of about eight miles. This picture shows the scanty vegetation and absence of timber characteristic of the Alaska Peninsula.

home with a sail-maker's needle and palm. In fact, although we all worked on it, he was really the one who made the tent habitable. Later he was again invaluable to us as a cobbler, for we found that we had to do most of our hunting in rubber boots on account of the wet, and the daily mountain climbing wore them out very rapidly. Each of the party wore out two pairs of rubber boots and two pairs of "shoe packs" (shoes with rubber feet and leather tops, theoretically water-proof to the knee), and when they were gone Mike cut off the legs of the rubber boots, which were still whole, and sewed them to some ordinary tramping boots which we had up to that time found no use for.

Our menu was very good most of the time, for the country contained quantities of caribou, Arctic hare, porcupine, and ground squirrels, besides ducks, ptarmigan, small shore and land birds, and an occasional goose and white swan. Of course the bay swarmed with gulls, and we found their eggs excellent and easy to gather, for, although Port Moller Bay is 10 miles long and four or five wide, it contains only two very small islands, and these are literally covered with gulls' nests. Our principal staple when we left the neighborhood of Gull Island was caribou meat, and we found it very good and that we did not tire of it as quickly as is the case with most game. The liver, eaten within twelve hours from the time the animal is killed, as is possible under these circumstances, is far better than the calf's liver one gets in the market, and is, in fact, entirely different in flavor.

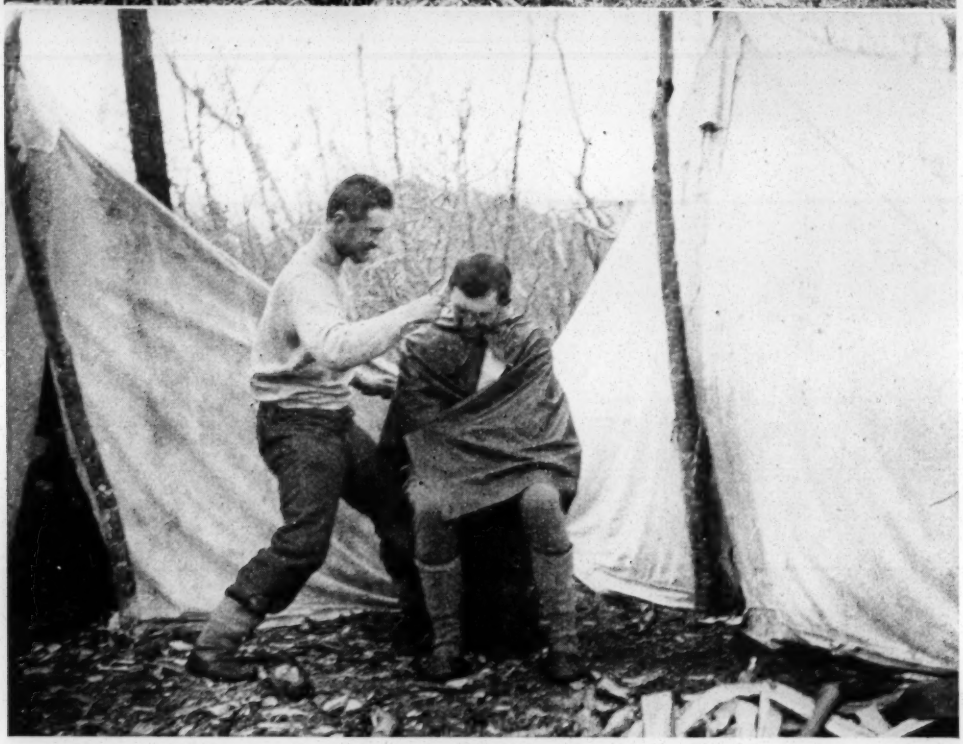
We had with us, of course, such staples as flour, sugar, baking powder, corn and oat meal, rice, salt, tea, bacon, and dried fruits, the latter being very acceptable in the absence of fresh vegetables.

The country is very rugged, and during the early weeks of our trip the heavy snow, soggy with the rain and fog, made hunting very difficult, especially as the bears kept well up to the tops of the mountains until the snow left the slopes bare, and they could browse on the young grass and alder buds lower down. We were soaked with the rain from morning until night, and the streams, fed by the melting snow and glaciers, are often waist deep and must be waded many times a day. They are so swift and rocky, however, that we had to tow the canoe up when we transported our dunnage from the boat to camp, and even running down we always prepared for a capsize and were seldom disappointed.

The method of hunting was, to the uninitiated, rather curious. We left camp about 7 o'clock and made ourselves comfortable on the first knoll which gave us a good view of the surrounding country. Here we spent from half an hour to two hours examining every foot of the country in sight with our field glasses, which were good binoculars, to discover a bear or some fresh tracks in the snow-fields. The bear were generally two or three miles away when first seen, and a long stalk, sometimes lasting four or five hours, followed, the shots being made at distances ranging from 50 to 350 yards.

If nothing was seen from the first lookout, we moved some miles to another and repeated the same tactics, the total country examined in a day by the whole party (which usually went out in two divisions, one taking Alfred and the other taking Mike) being enormous, although we seldom traveled more than 15 miles.

On one occasion, very early in the season, I was out with Alfred, and about 10 in the morning sighted a bear and a cub playing in the snow on the top of a ridge perhaps 300 feet above the valley floor. Our stalk was a difficult one, first over snow and then over slide-rock, where the slope was so steep that it was quite bare. Although the temperature was several degrees below freezing, we stripped to our undershirts and were dripping with perspiration before we reached the crest by the opposite slope from the bears. They had not gone far, and were about 75 yards away and below us. Between us and them we saw a hole in the snow, which turned out to be the den which they had just left after



A TYPICAL CAMP

The tents were always pitched in the middle of a clump of alders to prevent their being blown down. A small space was cleared for this purpose, and the alders which were cut down were then piled to form a wind-break. One of our cubs shows in the foreground, and behind her is a row of three bear skulls set out to dry.

HAIR CUTTING IN CAMP

BEAR HUNTING AS IT IS ACTUALLY PRACTICED (SEE PAGE 324)

Bear hunting grows more difficult as the snow exposes the brown grass, which is nearly the color of the bears. The daily discussion as to which tracks visible on the snow slopes 3 or 4 miles away were there the day before.

FRESH-KILLED BEAR

He stood 5 feet from the sole of his fore foot to the top of his back (not including the fur). He weighed about 800 pounds. A grizzly bear weighs half as much

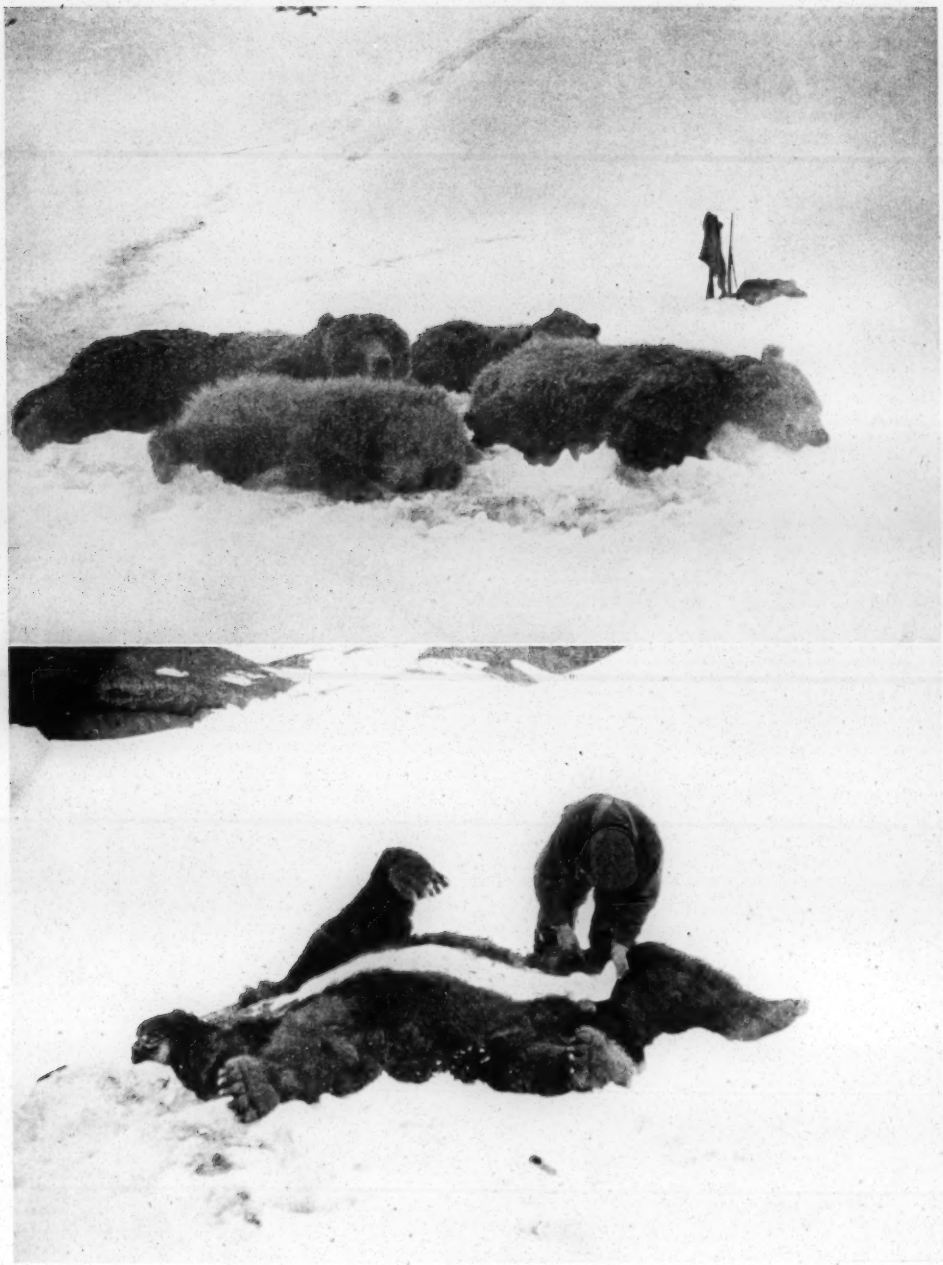
BEAR PARTLY SKINNED

This bear had a rear foot measuring 16⅝ inches from the heel to the base of the second toe-nail, and the fore pad was 11½ inches broad

FRESH-KILLED BEAR

The unstretched hide of this bear measured 11 feet 4 inches from the tip of the nose to the base of the tail

THE SAME BEAR: HIS STANDING HEIGHT WAS 4 FEET 8 INCHES



FOUR BEAR (AN OLD HE, SHE, AND TWO YEARLINGS) SHOT AT ONE TIME BY CROSS AND MYSELF

They were killed at the top of a mountain and rolled some three or four hundred feet down, and had to be dragged together—a rather difficult piece of work—to pose them for the picture.

SKINNING A BEAR

Mr Mixter's party shot 18 bear and brought back every skin

LITTLE WILLIE HAD A BROKEN LEG, AND WAS RATHER A SPITEFUL LITTLE RASCAL

FRITZI, PAULINE, AND LITTLE WILLIE IN CAMP

FRITZI AND HER BARREL

The barrel was her home for a week and was then abandoned as too clumsy, after which she, and later her companions, slept in the cook tent with the men.

FRITZI AFTER DINNER

their winter hibernation, and toward it they were now making their way. The old bear had evidently been warned of some danger, for she drove the cub into the den and continued alone toward where I was sitting with my gun ready.

I let her come to within about 50 yards, when she stopped and looked up, exposing her chest. She was my first bear and looked as big as a house, and it was not surprising, perhaps, that I shot high. She was growling, her mouth wide open, and my shot struck a canine tooth, glancing off without doing any damage, so I fired again with better effect. By this time the cub had heard the racket, so she came out of the den and proceeded to get mixed up in her mother's legs, making it hard to shoot without hitting the little fellow. After

LEADING FRITZI AND PAULINE DOWN TO THE BOAT AFTER BREAKING CAMP

THEY DISAGREE ON THE WAY DOWN

a while I got in another shot, and the old bear went somersaults down the snow slide, much to the horror of the cub, which took one look and made for the den.

Here Alfred followed her, and, with a great deal of trouble, managed to catch her by the ears and carry her squealing and fighting out of the hole. We made a collar of my gun sling and led her down to where the old bear had stopped, and then the heavy work of skinning began. It takes from one to three hours to do this job, and I for one was tired when we got back to camp at half-past 7.

Alfred had packed the skin, which, though not as large as many we got later, weighed 105 pounds, and I led the cub until she gave out, and then packed her the last mile to camp in my coat. After this she and the two others which we caught later lived in the cook tent with the boys, and soon learned to be decent members of society when left quite alone.

When we first caught them we had a good deal of trouble to make the cubs eat. We had neither the time nor the ingenuity to devise a makeshift nursing-bottle, and condensed milk was too much of a luxury to give it to them as a regular diet. This first cub, Fritzi, was the hardest to teach. At first she would slap a dish or spoon out of our hands, or else bite it and pull it away, so we made a thin oatmeal gruel with a good deal of milk and, holding a spoonful just out of reach, waited until the baby's rage got the better of her and she opened her mouth and wailed. Then a well-aimed toss sent a spoonful of gruel into her mouth, and she had to swallow it. It was a long process, but I cannot give any idea of how funny it was, as the noises and antics of this half-human baby are not to be described. After a while, by dint of much coaxing, the cubs learned how good the food was, and after that the mere sight of a dish was enough to set them squealing. In fact, when we were at meals, Fritzi would tease to be fed, and would wail most dismally if no notice were taken of her.

Luckily for all concerned, the men were devoted to the cubs; in fact, the suggestion that they live in the cook tent came from them, and the extra work for all of us caused no grumbling in camp. The cubs, Fritzi, Pauline, and Little Willie, kept well and healthy throughout the trip, and I think the boys were all very sorry when it came time to set sail for civilization and start the "babies" on their long journey to the bear dens of the National Zoological Park at Washington, where they now seem to be quite happy and absolutely at home.

THE ALASKAN BROWN BEAR

MR WILFRID H. OSGOOD, of the U. S. Biological Survey, gives the following account of the Alaskan bears in the last Yearbook of the Department of Agriculture:

Alaska is without a rival in respect to the number and the variety of its bears. They belong to four general types: the brown bears, the grizzlies, the black bears, and the polar bears.

The brown bears are the most numerous and most important. They are of huge size, being much larger than the grizzlies and all other bears except the polar bear and their own relatives of Kamchatka. Therefore the statement, often made, that they are the largest carnivorous animals in the world needs little, if any, qualification. They are confined almost exclusively to the coast region, ranging from Bering Sea throughout the Alaska Peninsula and some outlying islands, and thence south along the Pacific coast nearly or quite to British Columbia. Their color varies greatly, ranging from dark seal brown to buffy brown, the feet, legs, and underparts usually being darker than the shoulders and back. Although the ends of the hairs are often paler than the bases, the silver-tipped effect of the grizzlies is wanting. The front claws are shorter, thicker, and more abruptly curved than in the grizzlies.

It is often said that the brown bears

FRITZI ALWAYS TOOK A NAP AFTER DINNER, SLEEPING JUST AS A BABY WOULD

are less ferocious than the grizzlies, but the evidence is conflicting. Certainly they are more powerful and at close quarters correspondingly dangerous. They come out of hibernation early in the spring, usually in April. When the salmon begins to run they feed largely on them, and on this account have been called fish bears, or fish-eating bears, although other bears have the same habit. They eat a great variety of other food, however, including kelp and shellfish secured about the mouths of streams and along tide flats, and also berries, roots, ground squirrels, and mice, obtained on higher ground.

The brown bears of Alaska will doubtless become very rare or extinct at no very distant date. Such formidable carnivorous animals, even though not inclined to attack human beings, are commonly regarded as a menace to the safety of travelers, and therefore undeserving of protection. Already they have become scarce on Kodiak Island, where formerly very abundant, and on the Alaska Peninsula, though still fairly numerous, they are being killed at a rate probably greatly in excess of their increase. In the heavy forests of southeast Alaska and in the region of Mount Saint Elias they may hold their own longer.

THE PANAMA CANAL*

By Lieut. Col. Geo. W. Goethals, U. S. Army

Chairman and Chief Engineer, Isthmian Canal Commission

The following article was submitted to President Taft by Colonel Goethals, March 16, as a special report on the Panama Canal situation. The report gives such a complete and clear review of why the lock type of canal is being constructed that we publish it in full.

A CANAL connecting the Atlantic and Pacific Oceans has occupied public attention for upward of four centuries, during which period various routes have been proposed, each having certain special or peculiar advantages. It was not until the nineteenth century, however, that any definite action was taken looking toward its accomplishment.

In 1876 an organization was perfected in France for making surveys and collecting data on which to base the construction of a canal across the Isthmus of Panama, and in 1878 a concession for prosecuting the work was secured from the Colombian Government.

In May, 1879, an international congress was convened, under the auspices of Ferdinand de Lesseps, to consider the question of the best location and plan of the canal. This congress, after a two weeks' session, decided in favor of the Panama route and of a sea-level canal without locks. De Lesseps's success with the Suez Canal made him a strong advocate of the sea-level type, and his opinion had considerable influence in the final decision.

Immediately following this action the Panama Canal Company was organized under the general laws of France, with Ferdinand de Lesseps as its president. The concession granted in 1878 by Colombia was purchased by the company, and the stock was successfully floated in December, 1880. The two years following were devoted largely to surveys, examinations, and preliminary work. In the first plan adopted the canal was to be 29.5 feet deep, with a ruling bottom width of 72 feet. Leaving Colon, the canal passed through low ground to the valley of the Chagres River at Gatun, a distance of about 6 miles; thence through this valley, for 21 miles, to Obispo, where, leaving the river, it crossed the continental divide at Culebra by means of a tunnel, and reached the Pacific through the valley of the Rio Grande. The difference in the tides of the two oceans, 9 inches in either direction from the mean in the Atlantic and from 9 to 11 feet from the same datum in the Pacific, was to be overcome and the final currents reduced by a proper sloping of the bottom of the Pacific portion of the canal. No provisions were made for the control of the Chagres River.

In the early eighties after a study of the flow due to the tidal differences a tidal lock near the Pacific was provided. Various schemes were also proposed for the control of the Chagres, the most prominent being the construction of a dam at Gamboa. The dam as proposed afterward proved to be impracticable, and this problem remained, for the time being, unsolved. The tunnel through the divide was also abandoned in favor of an open cut.

The First Change from the Sea-Level to the Lock Type

Work was prosecuted on the sea-level canal until 1887, when a change to the lock type was made, in order to secure the use of the canal for navigation as

* See also "The Republic of Panama," William H. Burr, Nat. Geog. Mag., February, 1904. "The Panama Canal," Admiral Colby M. Chester and Gilbert H. Grosvenor, October, 1905. "The Panama Canal," Theodore P. Shonts, February, 1906.

soon as possible. It was agreed at that time that the change in plan did not contemplate abandonment of the sea-level canal, which was ultimately to be secured, but merely its postponement for the time being. In this new plan the summit level was placed above the flood line of the Chagres River, to be supplied with water from that stream by pumps. Work was pushed forward until 1889, when the company went into bankruptcy; and on February 4 that year a liquidator was appointed to take charge of its affairs. Work was suspended on May 15, 1889. The New Panama Canal Company was organized in October, 1894, when work was again resumed, on the plan recommended by a commission of engineers.

This plan contemplated a sea-level canal from Limon Bay to Bohio, where a dam across the valley created a lake extending to Bas Obispo, the difference in level being overcome by two locks; the summit level extended from Bas Obispo to Paraiso, reached by two more locks, and was supplied with water by a feeder from an artificial reservoir created by a dam at Alhajuela, in the upper Chagres Valley. Four locks were located on the Pacific side, the two middle ones at Pedro Miguel combined in a flight.

A second or alternative plan was proposed at the same time, by which the summit level was to be a lake formed by the Bohio dam, fed directly by the Chagres. Work was continued on this plan until the rights and property of the new company were purchased by the United States.

THE UNITED STATES BECOME INTERESTED

The United States, not unmindful of the advantages of an isthmian canal, had from time to time made investigations and surveys of the various routes. With a view to government ownership and control Congress directed an investigation of the Nicaraguan Canal, for which a concession had been granted to a private company. The resulting report brought about such a discussion of the advantages of the Panama route to the Nicaraguan route that by an act of Congress, approved March 3, 1889, a commission was appointed to—

> "make full and complete investigation of the Isthmus of Panama, with a view to the construction of a canal . . . to connect the Atlantic and Pacific Oceans . . . and particularly to investigate the two routes known respectively as the Nicaragua route and the Panama route, with a view to determining the most practicable and feasible route for such canal, together with the approximate and probable cost of constructing a canal at each of the two or more of said routes."

The commission reported on November 16, 1901, in favor of Panama, and recommended the lock type of canal. The plan consisted of a sea-level section from Colon to Bohio, where a dam across the Chagres Valley created a summit level 82 to 90 feet above the sea, reached by two locks. The lake or summit level extended from Bohio to Pedro Miguel, where two locks connected it with a pool 28 feet above mean tide, extending to Miraflores, the location of the final lock. The ruling bottom width of the canal prism was fixed at 150 feet, increased at the curves and in the submerged channels. In Panama Bay the width was fixed at 200 feet, and in the artificial channel in Limon Bay 500 feet was adopted, with turning places 800 feet wide. The minimum depth was 35 feet, and the locks were to have usable lengths of 740 feet and widths of 84 feet. The commission assessed the value of the rights, franchises, concessions, lands, unfinished work, plans, and other property, including the railroad of the New Panama Canal Company, at $40,000,000.

By act of Congress, approved June 28, 1902, the President of the United States was authorized to acquire, at a cost not exceeding $40,000,000, the property rights of the New Panama Canal Company on the Isthmus of Panama, and also to secure from the Republic of Colombia perpetual control of a strip of land not less than 6 miles wide, extending from the Caribbean Sea to the Pacific Ocean, and—

> "the right . . . to excavate, construct, and to perpetually maintain, operate, and protect thereon a canal of such depth and capacity as

will afford convenient passage of ships of the greatest tonnage and draft now in use."

In event the provisions for the purchase and for securing the necessary concession from Colombia could not be carried out, the President was authorized to secure the rights necessary for the construction of the Nicaraguan Canal.

The law also provided, after the foregoing arrangements had been perfected, that—

"the President shall then, through the Isthmian Canal Commission . . . cause to be excavated, constructed, and completed a canal from the Caribbean Sea to the Pacific Ocean. Such canal shall be of sufficient capacity and depth as shall afford convenient passage for vessels of the largest tonnage and greatest draft now in use, and such as may be reasonably anticipated."

To enable the President to carry out these provisions certain sums were appropriated and a bond issue, not to exceed one hundred and thirty millions of dollars, was authorized. By this act Congress, in accepting the estimates accompanying the report of the commission of 1901, adopted the type proposed by the board, or a lock canal.

Pursuant to the legislation, negotiations were entered into with Colombia and with the New Panama Canal Company, with the end that a treaty was made with the Republic of Panama granting to the United States control of a 10-mile strip, constituting the Canal Zone, with the right to construct, maintain, and operate a canal. This treaty was ratified by the Republic of Panama on December 2, 1903, and by the United States on February 23, 1904.

The formal transfer of the property of the New Panama Canal Company on the Isthmus was made on May 4, 1904, after which the United States began the organization of a force for the construction of the lock type of canal, in the meantime continuing the excavation by utilizing the French material and equipment and such labor as was procurable on the Isthmus.

THE INTERNATIONAL BOARD OF EXPERTS

The question of a sea-level canal was again agitated, and secured such recognition that the President convened an international board of engineers, consisting of 13 members, to assemble at Washington on the 1st day of September, 1905, for the purpose of considering the various plans for the construction of the canal that would be submitted to it.

The plans submitted may be briefly summarized as—

(1) That of the commission of 1901, which has already been explained.

(2) A lock canal with terminal lakes proposed by Mr Lindon W. Bates, and for which three projects were proposed. The one which he appeared to favor contemplated a summit level of 62 feet above the sea, created by a dam at Bohio, and an intermediate level of 33½ feet above mean tide, effected by a dam at Mindi. This plan provided four locks—at Mindi, Bohio, Pedro Miguel, and Sosa. A variant of the plan contemplated a dam at Gatun instead of at Bohio, showing that, at least for a 30-foot head, the Gatun location was not considered by him as unfavorable or offering any difficulties respecting the foundations. His other plans were modifications of this, the summit levels being 27 or 62 feet, but in each instance the lock type was advocated.

(3) The plan proposed by Mr Bunau-Varilla carried out the ideas of the first French company, namely, the construction of a lock canal with a summit level 130 feet above mean tide, to be ultimately converted into a sea-level canal, or what he calls the Straits of Panama. The locks were to be constructed so that as the levels were deepened by dredging they could be eliminated, navigation continuing during the enlargement and transformation. The material removed by the dredges was to be deposited in the lake formed of the upper Chagres River by a dam at Gamboa, and any suitable locations in the various pools between the locks. In commenting on

this plan the Board of Consulting Engineers concluded that—

"After a full and careful consideration of all the features of Mr Bunau-Varilla's plan, the board is of the opinion that it should not be adopted for the Panama Canal for the following reasons:

"1. The construction of the large locks required under the present law and necessary for the accommodation of the traffic seeking the canal after its completion makes it quite impossible to complete the preliminary lock canal even nearly within the period stated.

"2. The excessive cost of transformation added to the loss of costly locks and other appurtenant structures required by the preliminary lock canal.

"3. If the lock canal is likely to be retained for many years, it should be made for the most efficient service, and not be encumbered with modifications in lock construction which would prove inconvenient in use."

(4) A plan proposed by Maj. Cassius E. Gillette, a lock canal with a summit level 100 feet above mean tide by the construction of a dam across the Chagres Valley at Gatun.

No sea-level plan was submitted for consideration, so that the board outlined a general plan of its own, and for purposes of comparison adopted as the lock type a 60-foot summit level canal. Two levels were used; the summit level was carried by an earth dam at Bohio, and the intermediate level by an earth dam at Gatun, each dam sustaining a head of 30 feet. It is to be noted that no difficulties were anticipated in the construction of these dams, and there was no dread or fear of the foundations.

As the result of its deliberations, the board submitted a majority report and a minority report signed by five of its members, the former advocating a sea-level canal and the latter a lock canal, with the summit level 85 feet above mean tide.

THE LOCK TYPE IS ADOPTED

The Isthmian Canal Commission, with one dissenting voice, recommended to the President the adoption of the lock type recommended by the minority, which was also strongly advocated by the then chief engineer, Mr John F. Stevens. The President, in the message to Congress dated February 19, 1906, stated:

"The law now on our statute books seems to contemplate a lock canal. In my judgment a lock canal, as herein recommended, is advisable. If the Congress directs that a sea-level canal be constructed its direction will, of course, be carried out; otherwise the canal will be built on substantially the plan for a lock canal outlined in the accompanying papers, such changes being made, of course, as may be found actually necessary, including possibly the change recommended by the Secretary of War as to the site of the dam on the Pacific side."

On June 29, 1906, Congress provided that a lock type of canal be constructed across the Isthmus of Panama, of the general type proposed by the minority of the Board of Consulting Engineers, and work has continued along these lines. As originally proposed, the plan consisted of a practically straight channel 500 feet wide, 41 feet deep from deep water in the Caribbean to Gatun, where an ascent to the 85-foot level was made by three locks in flight. The level is maintained by a dam approximately 7,700 feet long, one-half mile wide at the base, 100 feet wide at the top, constructed to 135 feet above mean tide. The lake formed by this dam, 171 square miles in extent, carried navigation to Pedro Miguel, where a lock of 30 feet lift carried the vessel down to a lake 55 feet above mean tide, extending to Sosa Hill, where two locks overcame the difference of level between the lake surface and the Pacific. Nineteen and eight-hundredths miles of the distance from Gatun to Sosa Hill had a channel 1,000 feet at the bottom, a minimum channel for 4½ miles through Culebra of 200 feet at the bottom. The balance of the distance varied in width to 800 feet, the larger portion of the entire canal being not less than 500 feet. The depth of water was fixed at 45 feet. The lake assured a perfect control of the Chagres River.

IMPROVEMENTS IN THE ORIGINAL PLANS

Certain changes have been made in the original project, the most important being the withdrawal of the locks from

LOW TIDE NEAR THE PACIFIC TERMINUS OF THE CANAL

The range of tide on the Pacific end is 20 feet, while at Colon it is only one foot

Sosa to Miraflores, which was recommended and adopted in December, 1907. This resulted in a change in the direction of the channel in Panama Bay. A breakwater is being constructed from Sosa to Naos Island which, by cutting off the silt-bearing cross-current, which has always been troublesome, protects the channel against silting.

A second change is the widening of the 4½ miles of Culebra cut to a width of 300 feet at the bottom. This was done by Executive order and was not made on the recommendation of the commission.

A third change is the location of the breakwaters in Colon Harbor. The necessity for these breakwaters was made apparent in the latter part of January, when a storm of some magnitude seriously interfered with shipping. As originally proposed for both the sea-level and lock types, the breakwaters were parallel to the axis of the channel excavated in Limon Bay. If so constructed, sufficient area would not be given to dissipate the waves entering head on into the channel, and they would not afford much, if any, protection to shipping. These breakwaters are to be built out from Manzanillo Island and Toro Point, so as to give a sheltered an-

chorage, and also an opportunity for such expansion to the waves as to break them up.

A fourth change is in the dimensions of the locks. As proposed by the minority they were 900 feet by 95 feet, usable lengths and widths. These dimensions were subsequently changed by the commission at the instigation of the President to dimensions 100 feet wide and 1,000 feet long. The width was again increased to 110 feet on the recommendation of the General Board of the Navy, so as to accommodate any possible increase in beam of future battleships.

SENSATIONAL AND MISLEADING STORIES ABOUT THE GATUN DAM

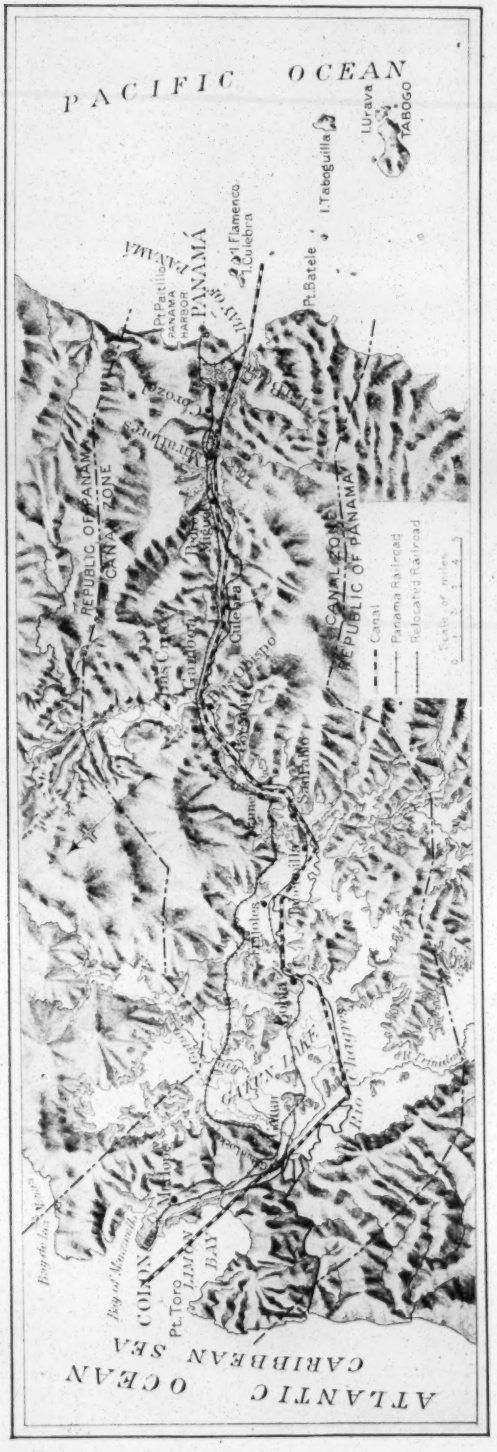
The Gatun dam is to consist of two piles of rock 1,200 feet apart and carried up to 60 feet above mean tide. The space between them and up to the required height is to be filled by selected material deposited in place by the hydraulic process. During the construction of the north side of the south rock pile a slip occurred in November last at the crossing of the French Canal. This was the fifth slip that occurred at this point, the rock settling to some extent, but generally slipping sidewise until the angle of repose was reached. In this connection it is to be noted that the silt deposits in the channel had not been removed. This slip would probably have passed unnoticed, as did the former ones, but for the fact that at the time a flood in the Chagres River had attained such proportions as to cover a portion of the Panama Railroad tracks just south of Gatun. A newspaper correspondent, going from Colon to Panama, saw his opportunity for a sensational story, and attributed the flood to the dropping of the Gatun dam into the subterranean lake under the dam and locks, which another faker had previously discovered, and the news of the destruction of the Gatun dam was cabled to the States.

The slip did not affect the south slope or side of the rock pile. It was entirely local and did not in any way interfere with the work. It would not have occurred had steps been taken during construction to give the proper slope to the rock pile, but economy of time and money did not warrant such precaution. As stated by one of the engineering publications, "We can state from actual personal examination that this incident has absolutely no engineering significance."

As a result, however, the public is told that dire disaster will follow the undertaking unless the present plans are abandoned and the Straits of Panama constructed—that is, a sea-level canal across the Isthmus 500 to 600 feet wide. To accomplish this, however, a lock canal must be built first, and subsequently widened and deepened until the ideal is reached. There is no data available for such a canal. With mountains instead of hills to be removed estimates are, of course, impossible; so the most optimistic figures, suitable alone to the ideal, are offered as a bait. In any event it is also claimed that Bohio should have been selected for the site of the dam in lieu of Gatun.

As between Gatun and Bohio, at both places the distance from the natural surface to the rock is so great that any attempt to found the dam on the last-named material will be attended by enormous expense. At Bohio the gorge in its lower strata is filled with water-bearing gravel, and to make the dam safe the underflow through these strata would have to be cut off by some means extending down 165 feet. No such strata exist at Gatun, so, for this reason alone, leaving out of consideration the advantages in the control of the Chagres River and to navigation by reason of the greater extent of lake, Gatun offers the better site.

Both the majority and minority of the Board of Consulting Engineers considered Gatun a suitable location for a dam; the former adopted it for the typical lock canal used for comparison with the sea-level canal, the latter for the 85-foot summit-level canal. The majority, however, feared the existence of an underground flow in case of the higher dam, but in-



SKETCH MAP SHOWING PANAMA CANAL AND GATUN LAKE

vestigations have failed to disclose any. The great mass of underlying material is not sandy and gravelly deposits, as was supposed, but a mixture of these materials so firmly cemented together with clay as to make the strata in which they occur impervious to water.

THE FOUNDATION OF THE DAM AND LOCKS AT GATUN IS SATISFACTORY

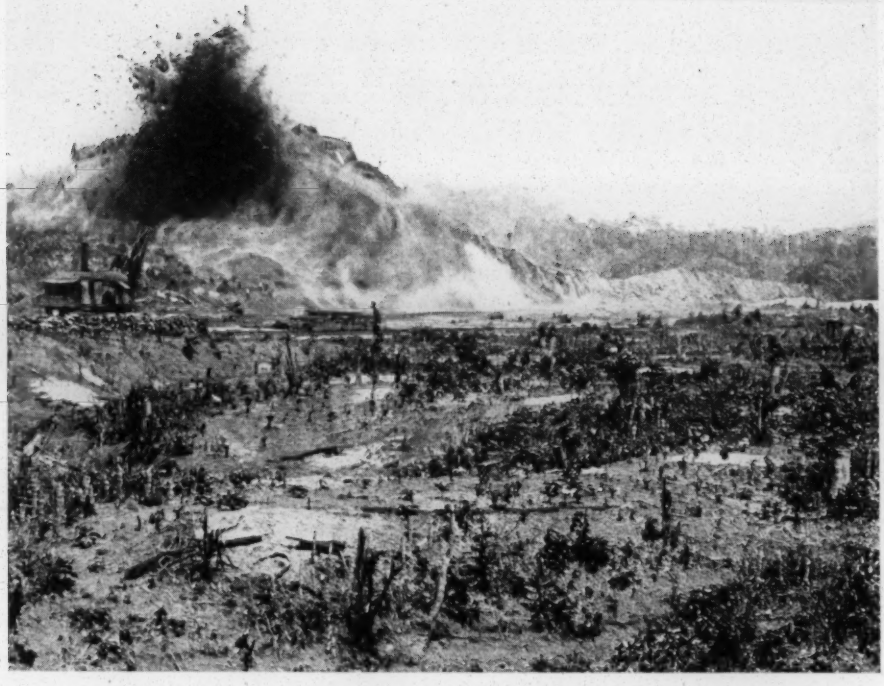
I venture the statement, without fear of contradiction, that the site of no public or private work of any kind has received such a thorough and exhaustive examination and investigation as the foundation of the dam and locks at Gatun. There is no longer a doubt concerning any of the underlying strata; neither the impermeability nor the ability of the foundations to bear the loads that will be brought upon them can be questioned if the data be carefully and impartially examined. The investigations fail to disclose any water-bearing strata or the existence of that underground stream with a discharge equal to the Chagres River itself, which was recently asserted as a fact on the floor of the Senate.

In this connection the statement is also made that the change in the location of the locks at the Pacific end was due to our demonstrated inability to construct the dams, and that as the foundation at Gatun is of the same material, it necessarily followed that the Gatun dam is also impossible of accomplishment.

The majority of the Board of Consulting Engineers in its report states that—

> "The dam at La Boca, between San Juan Point and the Sosa Hill, unless carried down to bed rock at that location, would be placed upon a far worse foundation than that proposed at Gatun or Mindi. The La Boca site is one covered by an ooze of mud or silt, with some sandy material overlying the rock. . . . Unless some feature equivalent to that of a heavy masonry core characterized the design of the dam at this point, or unless a resort be made to dredging down to bed rock or near to it, and refilling with suitable material, or an earth dam at this location be made very massive, it would be in grave danger of being pushed bodily out of place by the pressure due to the head of water in the reservoir."

We found the material in the founda-



GREAT BLAST IN PROGRESS

25 holes; 19.5 tons dynamite; material displaced, 70,769 cubic yards

tions of these dams not only worse than at Gatun, but in nowise comparable. In the former a covering of ooze and silt, in the latter firm ground with a few soft or marshy spots.

THE LOCKS ORIGINALLY PLANNED FOR LA BOCA WERE WITHDRAWN FOR MILITARY REASONS

I know that the La Boca dams could be built to safely withstand the heads of water in the resulting lake by adopting either the method of dredging out the ooze or by giving massive dimensions to the superimposed structure. The engineering committee and the majority of the commission preferred the former method. In either case the cost would exceed the original estimates, and in addition it is a military blunder to push the locks to and beyond the proper line of defense, especially when the canal is a military necessity to this country. That the dams could be built is evidenced by the fact that the west toe of the Sosa-Corozal dam was carried across the valley on the ooze as an embankment for a railroad to be utilized in transporting stone for the Pacific locks. The charge, therefore, that the dams could not be constructed is not true, and the analogy at Gatun does not follow. Nor is there any truth in the statement that the military necessity was an afterthought, as has been insinuated.

I visited the Isthmus in 1905 with a committee of the Board of National Coast Defenses, with which I was as-

sociated at that time, for a study of the defenses of the canal. When the location of the locks at the Pacific end was fixed I was directed to call the Secretary of War's attention to the military necessity of withdrawing the locks to the interior. This I did, with the result that in forwarding the report of the Board of Consulting Engineers to the President he calls attention to the fact as follows:

> "The great objection to the locks at Sosa Hill is the possibility of their destruction by the fire from an enemy's ship. If, as has been suggested to me by officers of this department entitled to speak with authority on military subjects, these locks may be located against and behind Sosa Hill in such a way as to use the hill as a protection against such fire, then economy would lead to the retention of this lake. . . . If, however, Sosa Hill will not afford a site with such protection, then it seems to me wiser to place the locks at Miraflores."

In forwarding the report to Congress, the President calls attention to the change recommended by the Secretary of War in the location of the locks on the Pacific side. The so-called afterthought appears, therefore, as a conclusion reached long before I had any connection with the work.

WHY THE GATUN DAM WAS REDUCED IN HEIGHT

Discredit is also thrown on the Gatun dam because there has been a desire to reduce the height from 135 to 105 feet. The original height was arbitrarily fixed to secure an excess of weight, so as to fully compress the underlying material, supposed to be largely silt deposited by the river. Subsequent investigations show that the supposed compressibility does not exist; that a marine, not a river deposit is encountered. The greater the height of the dam the greater the difficulty of constructing the upper portion, and the greater the cost, both in time and money. From present available data, if the lake should take the total discharge of the Chagres River, the water surface would not exceed 90 feet; the top of the locks, 92 feet above sea-level, would permit escape of the water long before it could reach the crest of the dam. Why then go to the expense of the extra height of the dam, and what is to be gained thereby? Assuming the crest of the dam as 100 feet wide, uniform slopes from the rock piles would give a height of 105 feet, and this height was suggested. Because as an additional reason it was mentioned that the pressure over the base would be more uniformly distributed by a dam with the cross-section proposed, the opponents of the present project, without ascertaining the facts, point to the change as a desire to secure a uniform base pressure, and use it as an argument against the stability of the foundation.

Much also has been made of the fact that in the testimony before one of the congressional committees mention was made of securing the stability of the superstructure by balancing the dam on the underlying material. Naturally the testimony is read and discussed in such a way as to leave the impression that the entire dam is to be so constructed. The ground to be covered by the dam is crossed by three water-courses, the Chagres River, the French Canal, and the West Diversion, and between these streams the ground is undulating, Spillway Hill reaching a height of 110 feet above sea-level. It is not remarkable or unprecedented that there should be depressions which undrained become soft with the excessive rainfall. Except for these, the ground is firm. It is in the crossing of these soft spots that slips have occurred and are liable to occur, and to which the balancing method referred. They are relatively small in extent and when drained or filled cause no trouble, as experience at the La Boca embankment clearly proves.

As previously stated, the Gatun dam satisfactorily solves the problem of the control of the Chagres, and there should be no doubt in the mind of any one who impartially examines the data that the solution is not only feasible, but absolutely safe. As there has never been any question raised as to the safety and stability of the dams at Pedro Miguel and Miraflores, with the Gatun dam accepted, other things being equal, the relative

merits of the lock *versus* sea-level canal must rest upon the ease and safety of navigation offered by the two types.

THE SEA-LEVEL TYPE MAKES NO PROVISION FOR CONTROLLING THE FLOODS OF THE CHAGRES RIVER

In the sea-level type offered in lieu of the lock type already described, the Chagres River is controlled by a masonry dam across the valley at Gamboa 4,500 feet long, 750 feet of which is subject to a pressure due to a head of 170 feet during the extreme flood stages of the river. Proper sluice gates are proposed for discharging the river into the canal. The difference in tides is overcome by means of a lock on the Pacific side in the vicinity of Sosa Hill. While provisions are made for damming or diverting some of the streams that would otherwise enter the canal prism, not less than 22 flow directly into the canal, with no provision to control the currents or check the deposits of material carried by them during flood stages.

The prism of the canal is to have a bottom width of 150 feet through the earth sections, or for nearly one-half its length, and a 200-foot bottom width through the rock sections. Nineteen miles of the length are made of curves, so that the proposed sea-level canal is not a wide, straight, and open channel, connecting the two oceans, but a narrow, tortuous ditch, with varying currents of unknown strength, impeded by a lock, and threatened by a dam resisting a pressure due to a head twice as great as that at Gatun.

To be sure, the partisans of the sea-level type are now proposing to eliminate both the Gamboa dam and the tidal lock by making the channel so wide as to reduce the currents that result from the discharge of the Chagres and the difference in tides, but fail to explain how they purpose to control or divert the Chagres, the bed of which will be 50 feet above the water surface of the canal at the juncture. As data is not available for preparing accurate estimates for even such a sea-level type as was originally offered, neither they nor any one else can offer any figures as to time and cost for the construction of such a canal as they now advocate.

In any comparison, therefore, we must confine our attention to the lock type as now building and a sea-level canal as offered by the board of engineers and not by the idealist.

FOR OUR BATTLESHIPS AND SHIPS OF COMMERCE THE LOCK TYPE IS QUICKER AND SAFER

So far as the two prisms are concerned, for ease and safety of navigation the lock type is better because of the greater widths of channels, fewer and easier curves, and freedom from objectionable and troublesome currents, both from the Chagres and its tributaries. This must be admitted by all, but the exponents of the sea-level type concentrate their attention on the obstructions and dangers that the locks constitute in the lock type, and also on the dangers that will result from the failure of the Gatun dam, forgetting that at least equally great disaster must follow the failure of the Gamboa dam. The lock in the sea-level canal is not mentioned, probably because the danger is not so great, since there is but one.

Experience shows that the risks to ships in narrow waterways are material and important. In such a channel as the original Suez Canal the delays and losses to commerce were great, and the danger to ships considerable; although the benefit of the widening is striking, this is true even now.

It is well known that the narrow channels connecting the Great Lakes have been obstructed repeatedly by vessels aground or wrecked in such a manner as to block traffic. Even in the entrances to our seaports there is a frequency of accidents which illustrate the difficulties encountered in navigating narrow and tortuous channels.

Accidents in locks have been relatively few, and none of a serious nature have occurred at the Saint Marys Falls Canal during fifty-four years of its use. The risks to ships in such a narrow waterway as proposed for the sea-level canal at

Panama far outweigh all hazards in the proposed lock canal, provided the latter is built so as to minimize the chance of accident at the locks. This is met by providing every possible safety device, by building the locks in duplicate, and by the installation of a system by which the vessels will be controlled by powerful electric machinery on the lock walls, thus avoiding mistakes on the part of the vessel's crew or engine-room staff, which once led to an accident at the Manchester Ship Canal.

Again, it is objected that the size of the locks limits the canal to vessels which can use them. This is true. The present lock designs provide intermediate gates dividing the locks into lengths of 600 and 400 feet. About 98 per cent of all the ships, including the largest battleships now building, can be passed through the 600-foot lengths, and the total lock length will accommodate the largest commercial vessels now building, which I believe are 1,000 feet long and 88-foot beam.

It is true that ships may increase in size so as to make the present locks obsolete, but the largest ships now afloat can not navigate the present Suez Canal nor the proposed sea-level canal at Panama. It must also be remembered that the commerce of the world is carried by the medium-sized vessels, the length of only one of the many ships using the Suez Canal being greater than 600 feet.

The General Board of the Navy is on record that 110-foot width will be ample for the future needs of the Navy, and naval construction of the future will be limited not alone by the locks of the Panama Canal, but also by the available dry docks. Ships that can not use locks 1,000 feet by 110 feet can not use a 150-foot sea-level canal, nor can this be so easily and economically increased and maintained as is made to appear by its advocates.

Increasing the width of Culebra cut, as recently ordered, from 200 to 300 feet is advanced as an argument to show that the locks are too narrow. Ships do not navigate the locks in the sense that they do the canal prism, and the wider the channel the easier will be navigation. On account of slides that developed in Culebra cut considerably more additional work was made necessary in the upper reaches of the divide than was contemplated, and the advantages of the increased width to navigation were so great, compared with the relative amount of material to be removed in order to secure it, that the President ordered it. By this action the width of the locks is in nowise called into question.

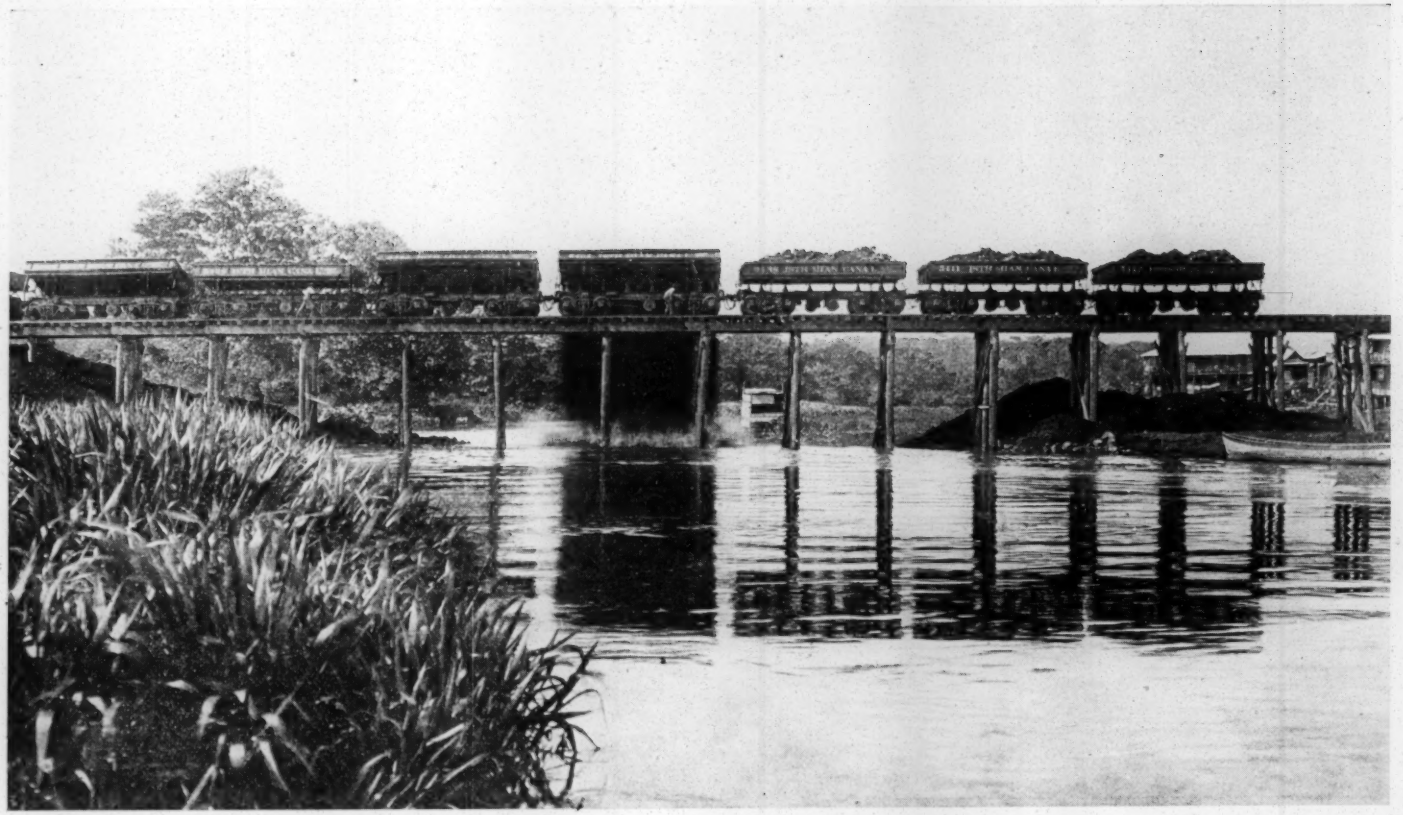
THE GATUN LAKE WILL NOT LEAK THROUGH THE HILLS

The water supply for lockages was so exhaustively treated by the minority of the board that it has not been called into question by any one who has carefully considered the report and data submitted therewith. Recently, however, the theory has been advanced that the water of the lake may seep through the adjacent hills or through the bottom, and is significantly referred to as a mooted question. This possibility is emphasized by the seamy quality of the rock when exposed. The French plans, with Bohio Lake, were the result of careful and protracted study and investigation, and nothing of the kind was anticipated. The commission of 1901 was not in doubt of the resisting power of the hill covering such a flow. The report of the geologist on the general formation of the country does not lead to any such dread or fear. The reservoirs, constructed in the hills of the same geological formation as the entire lake area, are not affected by any such leakage or seepage. At Black Swamp, an extensive area between Bohio and Gatun, the water stands above the level of the Chagres—which is within half a mile—and also above sea-level the level of the water remains unchanged, clearly indicating no such leakage.

Toward the close of the last dry season certain measurements of the Chagres at Bohio indicated a less discharge there than at Gamboa; this was subsequently exploded by other observations which

EXCAVATING FOR THE SITE OF THE GREAT GATUN DAM, LOOKING SOUTH

There are now on the Isthmus forty-eight 95-ton, forty-two 70-ton, ten 45-ton, and one 38-ton steam shovels, or a total of one hundred and one steam shovels



CLOSING OF THE CHAGRES RIVER AT GATUN

A single steam shovel at work on the Panama Canal recently removed 3,941 cubic yards of rock and earth in a working day of eight hours. This breaks all records for a single day's excavation by one steam shovel. The shovel was actually at work 6 hours and 50 minutes.

showed that the first ones were in error. Notwithstanding this, and in spite of the many evidences of the tightness of the earth covering, the possibility of a flow through the hills was advanced and was seized upon as another argument against the lock type.

A SEA-LEVEL CANAL WOULD PROBABLY COST TWICE AS MUCH AS THE LOCK CANAL

The Board of Consulting Engineers estimated the cost of the lock type of canal at $139,705,200 and of the sea-level canal at $247,021,000, excluding the cost of sanitation, civil government, the purchase price, and interest on the investment. These sums were for construction purposes only.

I ventured a guess that the construction of the lock type of canal would approach $300,000,000, and without stopping to consider that the same causes which led to an increase in cost over the original estimates for the lock canal must affect equally the sea-level type, the advocates of the latter argued that the excess of the new estimates was an additional reason why the lock type should be abandoned in favor of the sea-level canal.

The estimated cost by the present commission for completing the adopted project, excluding the items let out by the Board of Consulting Engineers, is placed at $297,766,000. If to this be added the estimated cost of sanitation and civil government until the completion of the work, and the $50,000,000 purchase price, the total cost to the United States of the lock type of canal will amount to $375,201,000. In the preparation of these estimates there are no unknown factors.

The estimated cost of the sea-level canal for construction alone sums up to $477,601,000, and if to this be added the cost of sanitation and civil government up to the time of the completion of the canal, which will be at least six years later than the lock canal, and the purchase price, the total cost to the United States will aggregate $563,000,000. In this case, however, parts of the estimate are more or less conjectural—such as the cost of diverting the Chagres to permit the building of the Gamboa dam and the cost of constructing the dam itself. Much has been said of the disadvantage of the seamy rock in connection with some experiments made at Spillway Hill test pit and of the so-called "indurated clay," yet these same disadvantages apply to the foundation at Gamboa, and the same class of material must be dealt with. The cost of constructing and maintaining a channel through the swamps of the lower Chagres is an unknown factor, and no schemes have been developed for controlling the various streams that are encountered and that must be reckoned with along the route of the canal. So that the sea-level estimates have not the accuracy of those for the lock type.

The majority of the Board of Consulting Engineers estimated that from ten to thirteen years would be required for the completion of the sea-level canal. The Isthmian Canal Commission and the then Chief Engineer fixed the time from eighteen to twenty years. It will take at least six years to complete the dam at Gamboa, and until the control of the Chagres River is assured, little if any excavation can be carried lower than 40 to 50 feet above sea-level; so that, in the absence of anything more definite, the time needed to construct the Gamboa dam is assumed as the additional period needed for completing the sea-level type.

THE COST OF THE CANAL EXCEEDS THE ORIGINAL ESTIMATES BECAUSE OF UNFORESEEN CONTINGENCIES

Much criticism has resulted because of the excess of the present estimates over those originally proposed, arising largely from a failure to analyze the two estimates or to appreciate fully the actual conditions.

The estimates prepared and accompanying the report of the consulting engineers were based on data less complete

than are available at present. The unit costs in the report of 1906 are identical with those in the report of 1901, and since 1906 there has been an increase in the wage scale and in the cost of material. On the Isthmus wages exceed those in the United States from 40 to 80 per cent for the same class of labor. The original estimates were based on a ten-hour day, but Congress imposed the eight-hour day. Subsequent surveys and the various changes already noted have increased the quantity of work by 50 per cent, whereas the unit costs have increased only 20 per cent—not such a bad showing. In addition, municipal improvements in Panama and Colon, advances to the Panama Railroad, and moneys received and deposited to the credit of miscellaneous receipts aggregate $15,000,000, which amount will eventually and has in part already been returned to the Treasury. Finally, no such system of housing and caring for employees was ever contemplated as has been introduced and installed, materially increasing the overhead charges and administration.

DREDGING DEVICES IMPRACTICABLE

Much stress has been laid upon the fact that recent improvements in machinery have so modified conditions that the excavation can be done more economically by special devices in conjunction with dredging than is possible with the methods now adopted. The machines referred to are for shattering rock under water, and, though it is claimed that such devices have given satisfactory results in connection with the Manchester Ship Canal, it is known that similar appliances have failed in certain localities in the United States where they were tried. The variations in the character of the rock on the Isthmus from soft argillaceous sandstone to hard trap are such as to make the use of such devices very problematical. Experience generally has shown that more money can be wasted on subaqueous rock excavation than in the removal of such material in the dry. Experiments are now being made on the Isthmus with one of these rock-crushing devices, but thus far the results are not promising.

PROBABLE EFFECT OF EARTHQUAKES

Much has been written recently concerning the probable effect of earthquakes. The last earthquake of any importance occurred in the seventeenth century, and existing ruins in Panama demonstrate clearly that no shock of any violence could have occurred during the eighteenth or nineteenth centuries. Should an earthquake visit the Isthmus the chances are that the effect upon the Gatun dam would be less disastrous than upon the Gamboa dam. The solid concrete construction of the locks, strengthened by reënforcements, will be as proof against any earth shocks as any structure which man builds anywhere, and the sea-level canal has as much to fear as the lock canal.

The vulnerability of the lock canal in time of war is another argument advanced in favor of the sea-level type, but has little weight, as the sea-level type is equally vulnerable from attacks by land or air in its Gamboa dam as are tidal locks and the various devices for controlling the streams along the route.

THE OPEN DITCH, FROM SEA TO SEA, AN IMPOSSIBILITY

The idea of the sea-level canal appeals to the popular mind, which pictures an open ditch offering free and unobstructed navigation from sea to sea, but no such substitute is offered for the present lock canal. As between the sea-level and the lock canal, the latter can be constructed in less time, at less cost, will give easier and safer navigation, and in addition secure such a control of the Chagres River as to make a friend and aid of what remains an enemy and menace in the sea-level type.

In this connection attention is invited to the statement made by Mr Taft, when Secretary of War, in his letter transmitting the reports of the Board of Consulting Engineers:

"We may well concede that if we could

have a sea-level canal with a prism of 300 to 400 feet wide, with the curves that must now exist reduced, it would be preferable to the plan of the minority, but the time and cost of constructing such a canal are in effect prohibitive."

We are justly proud of the organization for the prosecution of the work. The force originally organized by Mr John F. Stevens for the attack upon the continental divide has been modified and enlarged as the necessities of the situation required, until at the present time it approaches the perfection of a huge machine, and all are working together to a common end. The manner in which the work is being done and the spirit of enthusiasm that is manifested by all forcibly strikes every one who visits the works.

The main object of our being there is the construction of the canal; everything else is subordinate to it, and the work of every department is directed to the accomplishment of that object.

In addition to the department of construction and engineering, there are the departments of sanitation and civil administration, the quartermaster's and subsistence departments, the purchasing department organized in the United States, the legal department, and the departments of examination of accounts and disbursements. Subordinated to, but acting in conjunction with, the commission is the Panama Railroad.

THE CANAL ZONE HAS BECOME ONE OF THE HEALTHIEST REGIONS IN THE WORLD

Too much credit cannot be given to the department of sanitation, which, in conjunction with the division of municipal engineering, has wrought such a change in the conditions as they existed in 1904 as to make the construction of the canal possible. This department is subdivided into the health department, which has charge of the hospitals, supervision of health matters in Panama and Colon, and of the quarantine, and into the sanitary inspection department, which looks after the destruction of the mosquito by various methods, by grass and brush cutting, the draining of various swampy areas, and the oiling of unavoidable pools and stagnant streams.

According to the statistics of the health department, based on the death rate, the Canal Zone is one of the healthiest communities in the world, but in this connection it must be remembered that our population consists of men and women in the prime of life, with few, if any, of the aged, and that a number of the sick are returned to the United States before death overtakes them.

To the sanitary department are also assigned 11 chaplains employed by the commission to attend the sick, as well as to look after the spiritual welfare of the employees. At most of the villages there is a combined church and lodge house, so constructed that the lower floor is used for divine service, while the upper part provides places for meetings of the various lodges. The assignment of time to ministers and to lodges is made by the quartermaster's department.

The department of civil administration exercises supervision over the courts, which consist of three circuit and five district judges; the three former, sitting *in banc*, constitute the supreme court. The district courts take cognizance of all cases where the fine does not exceed $100 or imprisonment does not exceed thirty days. Jury trials are restricted to crimes involving the death penalty or life imprisonment—in short, summary justice rules, and so long as the zone is nothing more nor less than a construction camp this form of law or justice will continue to be the most satisfactory.

The department of civil administration has charge also of the police force, the post-offices, collection of customs and taxes, the issue of licenses, and the public school system. The schools are improved to such an extent that the children of the employees have very nearly the same advantage as in the United States up to and including the high-school courses.

THE LABORERS

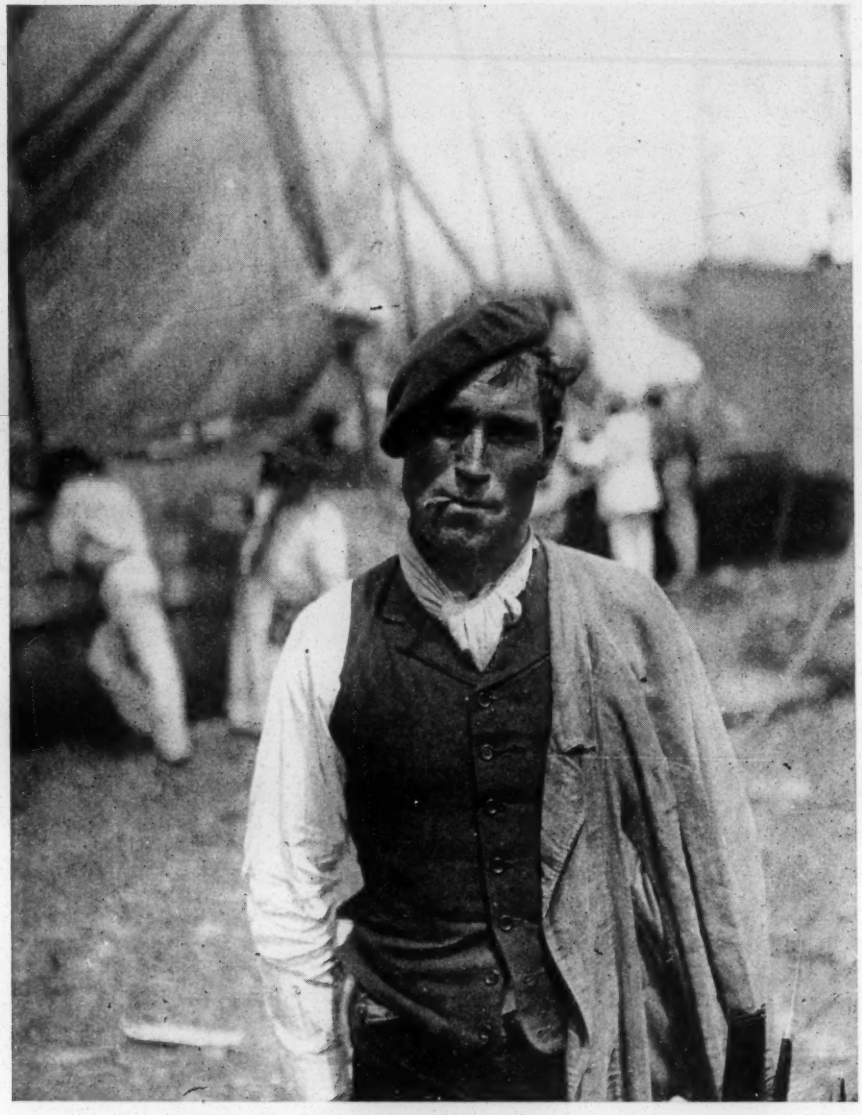
The quartermaster's department has charge of the recruiting of labor, the care, repair, and maintenance of quar-

A STREET IN PANAMA BEFORE THE AMERICAN RENOVATION

This street formed one of the plague spots

THE SAME STREET AFTER IT HAD BEEN RECONSTRUCTED BY THE AMERICAN GOVERNMENT

All the streets of Panama and Colon have been renovated in the same manner



A BASQUE FROM SPAIN, WORKING ON THE CANAL

In the month of March, 1909, there were actually at work 31,071 men, 24,911 for the Commission, and 6,160 for the Panama Railroad Company. Of the 24,911 men working for the Commission, 4,278 were on the gold roll, which comprises those paid in United States currency, and 20,633 men on the silver roll, which comprises those paid on the basis of Panaman currency on its equivalent. Those on the gold roll include mechanics, skilled artisans of all classes, clerks, and higher officials, most of whom are Americans; those on the silver roll include principally the common laborers, who are practically all foreigners. Of the 6,160 Panama Railroad employees, 838 were on the gold roll.

ters, the collection and disposal of garbage and refuse, the issue of furniture, and the delivery of distilled water and commissary supplies to the houses of employees, and is to have charge of the construction of all new buildings. Operating in conjunction with the purchasing department in the States, the quartermaster's department secures all supplies needed for construction and other purposes and makes purchases of materials on the Isthmus when required.

The common-labor force of the commission and the Panama Railroad aggregates in the neighborhood of 25,000 men, and consists of about 6,000 Spaniards, with a few Italians, the remainder being from the West Indies. The Spaniard is the best laborer, as he possesses more strength and endurance. Under some conditions this is not true, the foreigner strenuously objecting to doing work that requires him to stand in water.

All the skilled labor, the clerical force, and the higher officials are Americans and are recruited through the Washington office.

This department also has charge of all the property records, receives semiannual returns of property from all those to whom property has been issued, and checks the returns and inventories of the storehouses, made at certain times, with the records compiled from original invoices.

THE HOTELS AND MESSES FOR THE MEN

The subsistence department has charge of the commissaries and the manufacturing plants, which consist of an ice and cold-storage establishment, a bread, pie, and cake bakery, a coffee-roasting outfit, and a laundry. These belong to the Panama Railroad Company, as, at the time they were established, money received from sales could be reapplied, whereas if operated by the commission the money would have reverted to the Treasury, necessitating reappropriation before the proceeds of sale could be utilized. They are, however, under the management of the subsistence officer of the commission, who has charge of the various hotels, kitchens, and messes of the commission.

There are 16 hotels from Cristobal to Panama, which serve meals to the American, or gold, employees at 30 cents per meal. There are 24 messes where meals to European laborers are served, the cost per day to such laborers being 40 cents; and there are 24 kitchens, or messes, for meals supplied to the silver laborers, or West Indians, the cost to the laborer being 30 cents per day for three meals. Subsistence is furnished without profit to the commission, though every effort is made to have the institutions self-supporting. The commissaries and manufacturing plants are operated at a profit, so as to reimburse the Panama Railroad Company for its outlay in six years from January 1, 1909, at 4 per cent interest.

The subsistence department also has charge of the Hotel Tivoli, which is a large hotel located at Ancon, for the entertainment of the commission's employees at a comparatively low rate, and of transient guests at rates usually charged at first-class hotels.

All moneys are handled by the disbursing officer, who pays accounts that have been previously passed upon by the examiner of accounts. This last-named official makes the administrative examination required by law prior to the final audit of the accounts by the Auditor for the War Department. The pay rolls are prepared from time books kept by foremen, timekeepers, or field clerks, subsequently checked by the examiner of accounts, who maintains a force of time inspectors. The time inspectors visit each gang, generally daily, at unknown times to the foreman, timekeeper, or field clerk, and check the time books with the gangs of workmen; the inspectors report to the examiner of accounts the results of their inspection not only in connection with timekeeping, but all violations of the regulations of the commission that may come under their observation.

Payments of pay-rolls are made in cash, beginning on the 12th of each month and consuming four days for the

entire force on the Isthmus. All American employees and European laborers are paid in gold; all on the so-called "silver roll" are paid in Panamanian silver.

THE ENGINEERING DEPARTMENT

The department of construction and engineering is under the direct charge of the Chief Engineer. He is assisted by the Assistant Chief Engineer, who considers and reports upon all engineering questions submitted for final action. The Assistant Chief Engineer has charge of the designs of the locks, dams, and spillways, and supervision of these particular parts of the work. There is attached to the Chief Engineer an assistant to the Chief Engineer, who looks after mechanical forces on the Isthmus and has supervision over the machine shops, the cost-keeping branch of the work, the apportionment of appropriations, and the preparation of the estimates. There is also an assistant engineer, who has charge of all general surveys, meteorological observations, and river hydraulics.

The zone is divided territorially into three divisions, each in charge of a division engineer, the first extending from deep water in the Caribbean south to include the Gatun locks and dams, known as the "Atlantic Division." The second, or "Central Division," extends from Gatun to Pedro Miguel, and includes the excavation through the continental divide. The third, or "Pacific Division," extends from Pedro Miguel, including the locks and dams of that locality, to deep water in the Pacific.

The general plans emanate from the office of the Chief Engineer and the details are left to division engineers, subject to the approval of the Chief Engineer. The whole idea of the organization in the department of construction and engineering, and in fact of all the work, is to place and fix responsibility, leaving to each subordinate the carrying out of the particular part of the work intrusted to his charge.

Each division engineer has charge not only of the work involved in the construction of the canal, but all municipal engineering, including water supply, building and maintaining roads, and the establishment and maintenance of sewer systems. With the force under his charge the division engineer executes such sanitary draining as may be prescribed by the chief sanitary officer, so that all construction work, excepting the construction of buildings, concerning the location of which the division engineer is consulted, however, is directly in the hands of the division engineer.

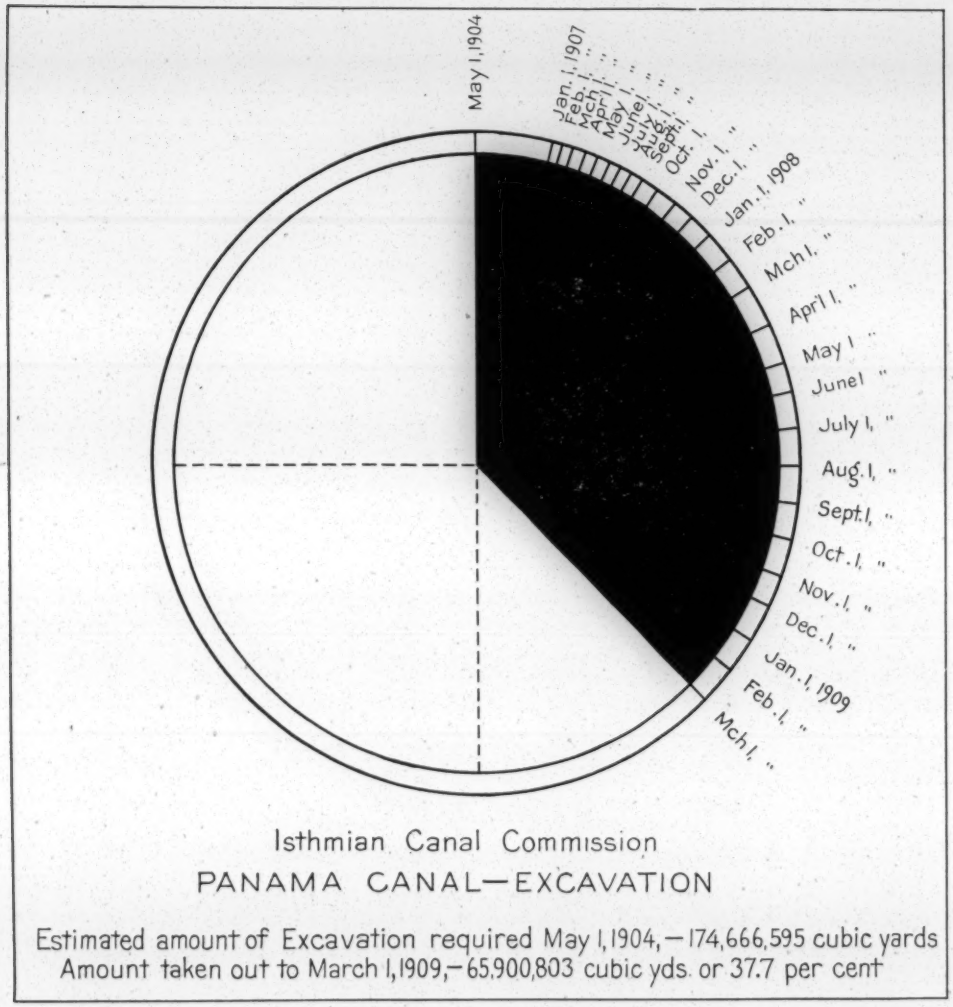
THE Y. M. C. A.

Attached to the office of the chairman is a general Y. M. C. A. secretary, who has supervision of the commission's club-houses, which are operated and maintained under the auspices of the Y. M. C. A. Four of these are now constructed and in operation, and four more are to be built from funds recently made available by Congress. They have done much toward securing a greater permanency to the force, in giving healthful amusement, and to a better contentment on the part of the employees.

I have endeavored to show that a channel of sufficient width, in which the waters of the many streams, especially the Chagres, will not be a menace, is one most desired for an Isthmian Canal. The sea-level canal proposed by the majority of the Board of Consulting Engineers is not of sufficient width, nor is the proposed solution for the impounding and diversion of the Chagres and other streams based upon sufficient investigations to insure its success. The "ideal" sea-level canal, the Straits of Panama, recently proposed, is not based upon any investigations of the work to be done and cannot, in view of the approximate estimate of the cost of our own sea-level canal, which is about one-third the size of the "ideal" plan, be given serious consideration. Every criticism against the stability of our locks or dams can be attributed to either an argument in favor of one's own plans or to absolute ignorance of the exhaustive data concerning their safety now in existence. The sev-

eral other plans of lock-type canal have nothing in their favor that the plan now adopted does not possess to a greater degree.

I have endeavored also to show that the organization on the Isthmus is compact and complete in every way, performing its duties of construction, sanitation, and government with clock-like precision. I cannot do better than quote from the message recently sent to the Congress, "that hereafter attack on this type—the lock type—is in reality merely attack upon the policy of building any canal at all," for the adoption of a sea-level canal anywhere approaching the ease of navigation of the lock type will result in the ultimate abandonment of the canal; and I assure you that several years hence, no later than January 1, 1915, even the most ardent sea-level advocates will, in making the voyage through the canal, admit that the ability to navigate a battleship at a high rate of speed through the lake and wide channel from Gatun to Pedro Miguel far outweighs the small inconveniences of the safe lockages up to and down from the summit level.



Isthmian Canal Commission

PANAMA CANAL—EXCAVATION

Estimated amount of Excavation required May 1, 1904, — 174,666,595 cubic yards
Amount taken out to March 1, 1909, — 65,900,803 cubic yds. or 37.7 per cent

THE ORIGINAL BOUNDARY STONES OF THE DISTRICT OF COLUMBIA

By Ernest A. Shuster, Jr., U. S. Geological Survey

TOURISTS when at the National Capital are usually anxious to visit the home of Washington at Mount Vernon, and to examine the many relics of the great man which are exhibited there. Few, however, if any, realize that in the woods and fields surrounding the great city stand thirty-six little witnesses to the energy and foresight of our national hero and the men he gathered around him when laying the foundations of our government.

These thirty-six are all that are now visible of the forty original boundary stones of the District of Columbia. In the years 1791 and 1792 a party in charge of Major Andrew Ellicott, and under the general direction of President Washington, were engaged in laying out the limits of the "Federal Territory" to surround the then embryo capital city.

Upon glancing at the map, the original District is seen to have been an area ten miles square, with the diagonals running north and south, east and west, the south corner resting on Jones' Point, on the Potomac River, just below Alexandria, Virginia. The post marking this corner was set, with Masonic ceremonies, in April, 1791. The lines were then run to the east and west corners, thence closing at the north corner, not far from Fenwick, Md. The timber was cleared along the line, and the stone monuments set at intervals of a mile, except where the mile fell on unfirm ground or in a stream. The monument was then marked with the odd distance.

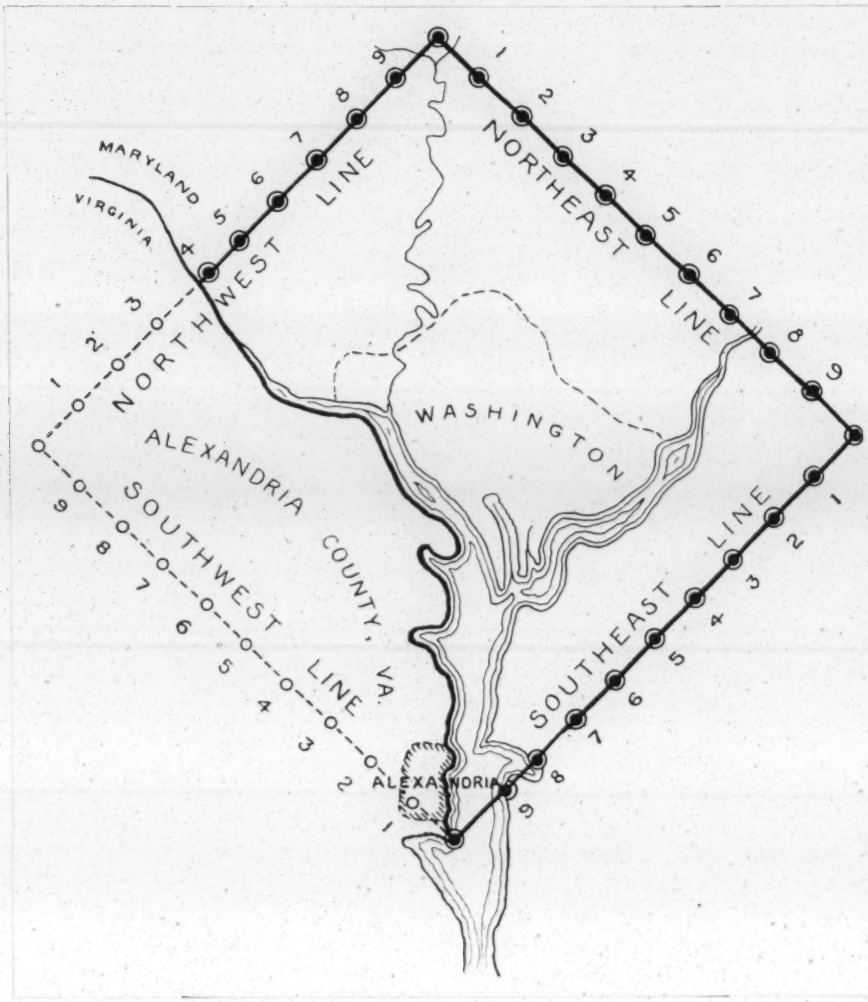
The material from which the posts were cut is the Acquia Creek (Virginia) sandstone, the posts being 12 inches square and 24 out of ground, the corner posts being 36 inches high, with the exception of the west corner, which is of the same size as the intermediate stones. Evidently a mistake was made, as there is a 36-inch stone at No. 3, on the southeast line. The stones appear to have been sawn from the rough, the saw marks being plainly visible on many. The words Jurisdiction of the United States, followed by the number of miles from the corner at which the series begins, appear on the side facing the District. Passing around the stone to the right, one is confronted with the figures 1791 or 1792, according as he is in Virginia or Maryland. The third side reads Maryland or Virginia, and on the fourth is given the magnetic variation at that time.

About twenty years ago the Coast and Geodetic Survey remeasured the District, and determined the exact position of the monuments, with the result that the four sides of the "square" were found to average 160 feet long in the ten miles, and the entire area is tipped westward on the south corner as a pivot, so that the north corner is 116 feet west of its proper position.

That part of the original District which lay west of the Potomac River was ceded back to Virginia in 1846, the area being now called Alexandria County. The line then ceased to have the importance of a State boundary, and for this reason, possibly, the monuments on this side of the river are not as easily found.

During the summer of 1908 I had the privilege of retracing the District line and visiting these old monuments in company with an interested relative and a camera with which to record their condition. It is, of course, impossible to reproduce all of the many photographs taken during the summer, but only those which show interesting features.

The south corner post lies buried behind the sea wall at the Jones' Point Lighthouse. The southeast, No. 7, is



MAP SHOWING THE ORIGINAL BOUNDARY STONES OF THE DISTRICT OF COLUMBIA

also buried in the approach of a small modern bridge, and of the southwest, Nos. 4 and 5, only the stumps remain, the 4 being buried and the 5 lying on the ground. The southwest, No. 2, no one seems to remember. The stone has been missing for many years.

On the side of the present District we had the advantage of the excellent large scale maps resulting from the work of the Geodetic Survey, of which I have spoken, but even with this assistance a little stone 12 inches square can be passed time and again within a few feet in a dense thicket. There was an indescribable pleasure in finding the stones by means of the maps, and in only two or three cases did we ask assistance from the people living in the vicinity. Twenty-three Sunday afternoons were spent in the search from the latter part of March to the end of August, six stones being our largest afternoon's work. On two evenings, however, we returned home without adding to our score.

For those visitors to Washington and vicinity who have the time and the desire to examine one of the stones, the

THE EAST CORNER

Taken from the inside of the District, the line enters the stone at the vertical line on each face, and makes the angle at the center of the stone.

NORTHEAST, NO. 5

For thirty years this stone has leaned at a decided angle. The cause is unknown

SOUTHEAST, NO. 8

Deeply buried in marshy ground, showing date

SOUTHEAST, NO. 4

No vestige of any lettering remains upon this stone, which is at the side of a well-traveled road.

SOUTHEAST, NO. 2

A stone with comparatively clean inscription, showing saw marks

NORTHEAST, NO. 7

Although this stone is badly seamed through the center, it is otherwise in better condition than any other.

northwest, No. 7, is perhaps in better condition than any of those most easily accessible. It is situated about a quarter of a mile southwest of Chevy Chase Circle, which is reached by trolley. A modern marker stands on the southwest margin of the circle, and the old stone may be found by walking in the direction of the line cut in the top of the marker. As the monument stands in an open field, it is easily seen. The northeast, No. 2, stands in the town of Takoma Park, also reached by trolley, and is on Maple street, about 100 feet northeast of its junction with Carroll street, at the end of a hedge.

It is to be hoped that the authorities will awake to the fact that if these monuments are not protected in some manner from the elements and the hands of vandals they will soon be lost to us, as the material is of a particularly friable nature. In spite of their dingy and battered appearance, the little stones with their quaint lettering seem to reflect the simple dignity of the days and people we all wish to keep in loving remembrance.

EDITORIAL NOTE.—Mr George Mixter, 2nd, author of the interesting article on "Hunting the Great Brown Bear of Alaska," published on pages 313–333 of this number, desires us to state that the illustrations accompanying the article are from photographs by the three members of the party, Dr C. G. Mixter, Mr C. R. Cross, Jr., and George Mixter, 2nd, and were not taken exclusively by the author.

THE LEACH'S PETREL: HIS NURSERY ON LITTLE DUCK ISLAND

By Arnold Wood

With Photographs by the Author

LITTLE DUCK ISLAND, nine miles south of Northeast Harbor, Mount Desert Island, Maine, is the nesting place for three species of sea birds—the herring gull, the black guillemot, or sea pigeon, and the Leach's petrel, also called white-rumped or forked-tailed petrel. This island is about half a mile long and a third of a mile wide, partly covered with scrub pines, underbrush, and wild raspberry bushes. Although its shores are very rocky, the interior is fairly well covered with soil, which is, however, not deep, as rocky ridges are to be seen in all directions. Among the birds above mentioned, the herring gulls, whose rookery is well known and who nest there from May until August, are to be seen by the thousand.

I doubt if it is generally known that the petrel lives there at all, though, as a matter of fact, I think I am conservative in saying that ten petrels nest on the island to every gull. While this island is occasionally visited in the daytime for the purpose of seeing the gulls, one would never know from any outward sign that the petrel is in point of numbers the chief inhabitant.

I have visited Little Duck Island a number of times, and studied the burrows of the petrel, which are found there in large numbers. These burrows or

A PETREL BURROW ON THE GROUND: THE PETREL IN THE FOREGROUND IS ABOUT TO ENTER THE NEST

A PETREL BURROW IN A BANK

tunnels are found in the banks and on the ground or under rocks all over the island. The petrels are especially fond of making them among the raspberry bushes, probably because of the fact that the ground is softer there, and consequently easier to tunnel. The tunnels are from 18 to 24 inches in length, with at least one turn, and descend at an angle of about 30 degrees. At the end the tunnel is slightly enlarged or scooped out, and a few straws and blades of grass gathered in a little heap constitute the nest on which the bird lays its one egg. This egg is about one and a quarter inches in length, white, with small faint reddish-brown spots on the large end, and is very fragile.

One of the birds is always on the nest during the day, while its mate is far out at sea. I say far out, as the petrel is very rarely seen near the coast. Some ornithologists have stated that the male bird usually sits on the nest during the day. While I am not in a position actually to disprove this, I doubt if it is the rule, my belief being founded upon recent observations, when spending the night among the petrels watching their nocturnal habits as they return from sea.

Their burrows or tunnels will just admit the hand and arm, and if one has a fairly long reach one can withdraw the sitting bird from the nest. They are comparatively tame, although, as a means of defense against any intruder in their nest, they will emit from the mouth about a teaspoonful of a reddish-brown fluid, which is most pungent and of a strong musky odor.

When brought into the light the birds seem to be somewhat blinded by the brightness, and for a few moments will pose most considerately; but they shortly become used to the change, and will work their way clear of the long grass and other obstructions until their wings are free, when they take to flight. On the

PETREL LEAVING NEST

NEST AND EGG

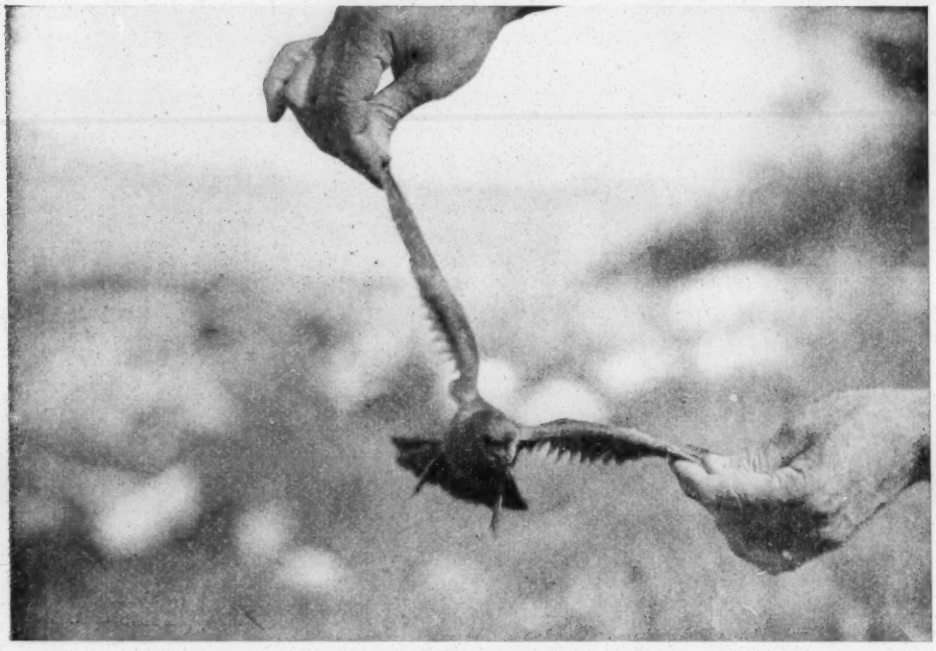
THREE ADULT PETREL IN HAND

ground they are most awkward, their very long wings, together with their webbed feet, interfering with their progress.

The night that I spent on the island gave me a better opportunity of watching the habits of this bird than I could have obtained in any other way. About dusk I walked to a certain spot where I knew there was a large number of their burrows, and sat down on a rock to await their return from sea. There were burrows within four feet of where I sat, and I speculated with much interest as to what effect my close proximity would have on the occupants when their mates returned.

About this time hundreds of gulls were returning to the island for the night, and before me, sitting on the rocks and flying in the air, were thousands of them, making the twilight hideous with their continual screeching and crying. As soon as night settled down, they in turn found roosting places on the rocks near the shore, and their cries became more and more faint, until at last the occasional note of but one or two could be heard, showing that nearly all the birds were asleep; then one faint cry and all was still, and a death-like silence fell upon the island.

Hardly had I time to appreciate the relief from the hours made hideous by the noise of the gulls, when from far out over the water there floated in a strange note, which I knew at once must be that of the petrel. Louder and louder this note grew, until at last two birds flew over my head, sailed around me, all the time uttering their sharp, wild, and guttural call. These two birds suddenly disappeared in the darkness, shortly to return with hundreds and hundreds of their kind, until the whole night seemed alive with them, flying with bat-like mo-



SHOWING THE GREAT EXPANSE OF PETREL'S WINGS

tions, each one crying out in the same notes and key.

They swooped down on me and around me, in one instance brushing my hat with their wings. They all seemed to be laboring under the greatest excitement, so great was the confusion. The whole island had come to life again; wherever one looked, wherever one went, the place swarmed with petrel; and they had it to themselves, for all the gulls leave the fields at night and roost on the rocks near the sea. After some fifteen minutes another note was heard, and on following the direction from where it came, I was led to one of the burrows, at the entrance of which stood the bird that had been on its nest all day, calling to its mate among the hundreds flying around in a most plaintive, sad little note.

They seem to have absolutely no fear of man—in fact, to ignore his presence—and will meet their mates almost at one's feet. After watching them for some time I returned to my tent, which I had erected on a wooded knoll, where I had not seen any of their burrows On arriving there, however, I was greatly surprised to find as many petrels as I had left behind, and it seemed as though they came out of the ground in every direction like so many ants.

Sleep was impossible, so great was the noise they made; but it was a different note from the one they uttered when arriving—a constant twitter, ending in a deep chirp, never ceasing for a moment. During all this time the birds were flying about, truly the busiest, most active little fellows I have ever seen. Just before dawn they suddenly stopped, and, on looking out of my tent, I found they were gone, every one of them, quicker even than they had come, six hours before. Hardly had I returned to the tent when the gulls awoke, and reigned supreme for another day. One might almost be led to believe that the petrel time their arrival and departure by the hours during which the gulls are silent.

I am inclined to believe that the female bird usually sits on the nest, and that her mate is the bird that is hunting far at sea, returning at night to feed her, busy

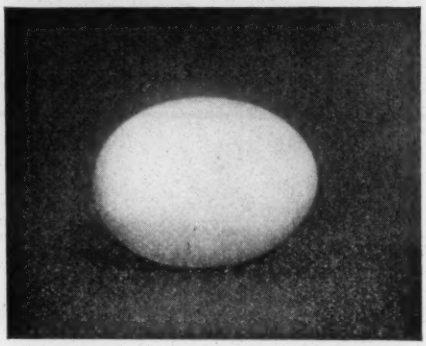
in that occupation until dawn, when he is off again.

They have three very distinct calls; one might be named "heralding their arrival"; another, when calling their mates to their respective homes, "the song of greeting," and a third, when they are flying about their nests, "the feeding notes."

After their departure in the morning the atmosphere is impregnated for a few hours with the odor of musk. They must emit this liquid while flying about their nests, for the bird has no odor beyond a slightly oily scent. Perhaps it is an instinctive habit, to make the surroundings objectionable to any of their possible enemies during the nesting season.

The young are hatched during the latter part of July, and by September 15 they are gone, not to return until the following year. The young are completely covered with the finest kind of mouse-colored down, and in the hand resemble a ladies' powder puff, both in size and texture. The parent birds as a rule leave the nest during the day after the young are hatched, returning at night for the purpose of feeding them. The young birds do not leave the nest until they attain nearly their full growth and plumage.

While the shores of the Bay of Fundy are the principal nesting-places for this bird, Little Duck Island certainly does its share as a nursery for the Leach's petrel. Thousands and thousands of these birds return to rear their young where they themselves were hatched. One marvels at the instinct which guides them on a foggy night, from several hundred miles out at sea, to a small spot on the ocean scarcely half a square mile in size, and on a course straighter than any ship could be steered. Upon arrival, each flies straight to his own burrow, although there are a hundred next to his, and to the human eye all look alike. Perhaps it is this same instinct which brings back the young another year to build their nests, as their ancestors have done, on the cliffs and fields of Little Duck Island.



EGG OF LEACH'S PETREL: NATURAL SIZE

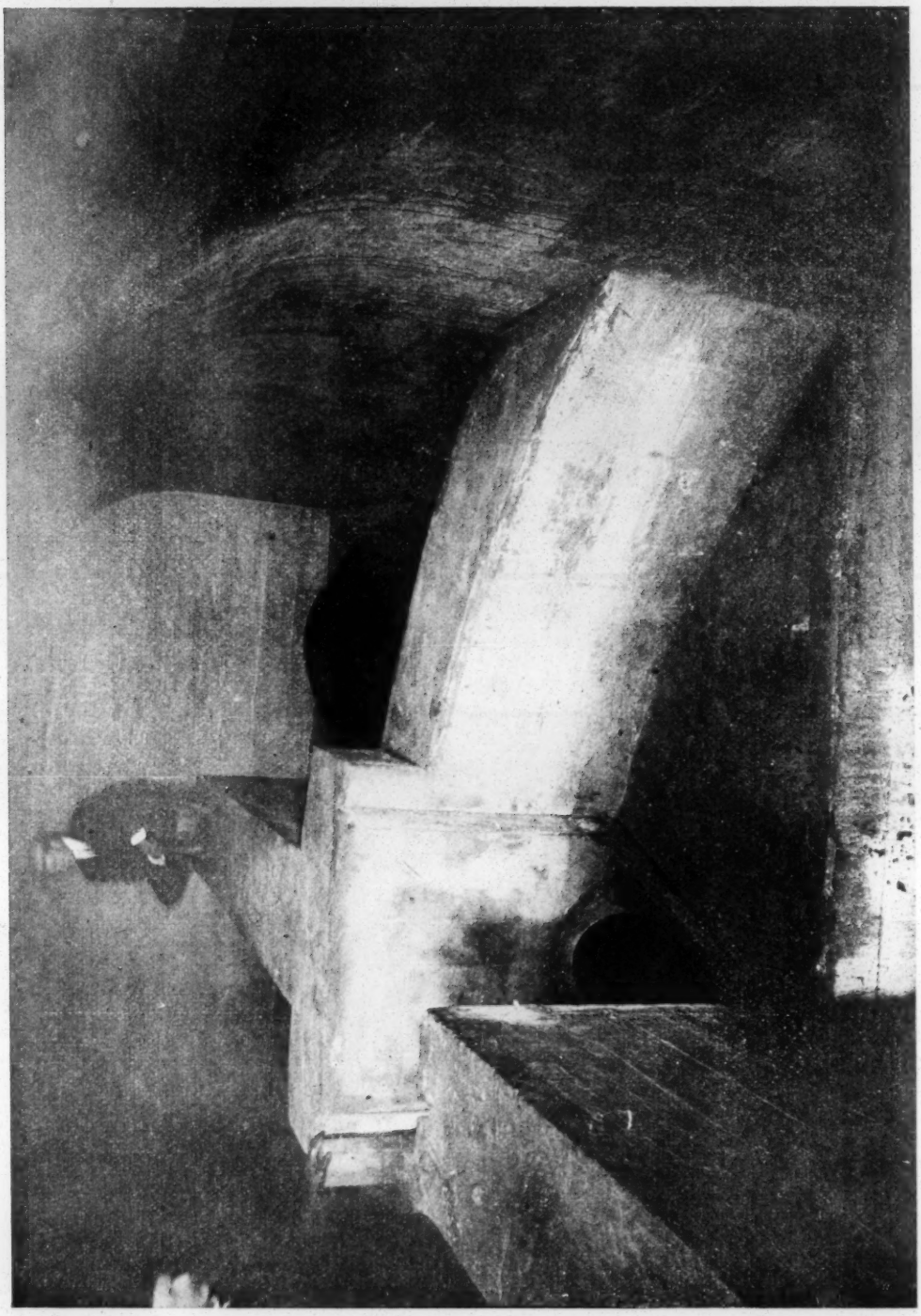
COLOSSAL WORK IN BALTIMORE

By Calvin W. Hendrick

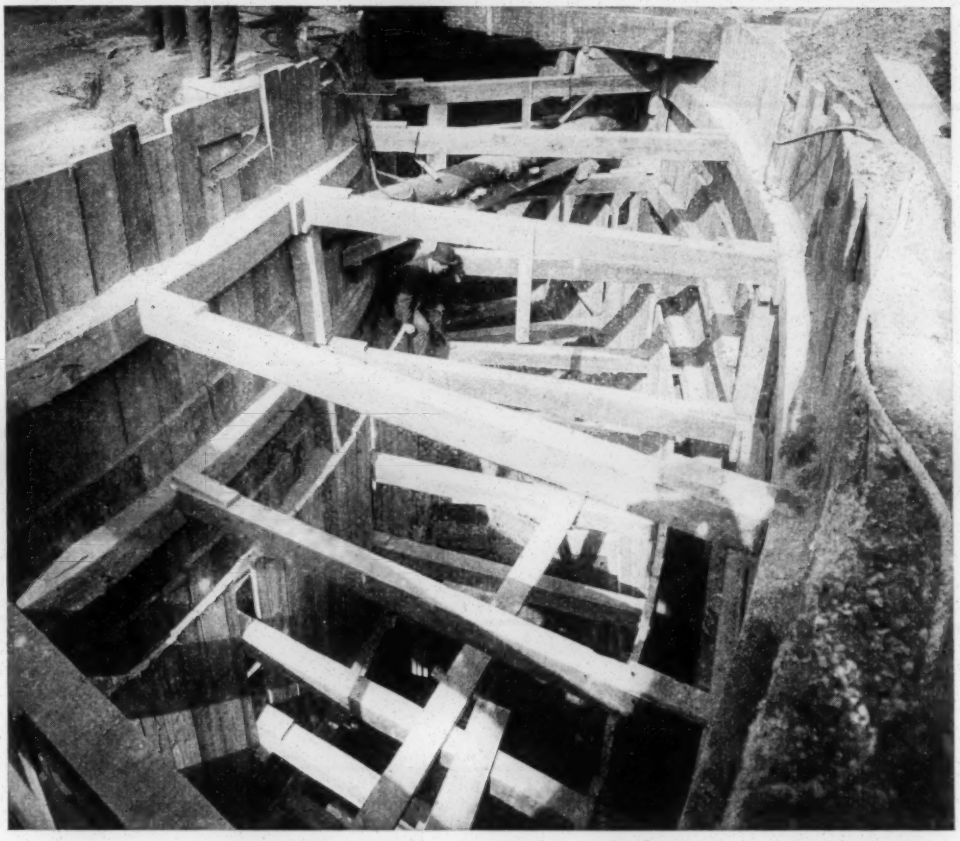
Chief Engineer, Sewerage Commission of the City of Baltimore

BALTIMORE, one of the oldest and most aristocratic cities of this country, has allowed itself to grow to a size of 700,000 people without a sewer system, depending on the old methods of disposing of the sewage by means of cesspools and otherwise.

In order to protect the oyster trade, one of her great industries, amounting to some fifty millions of dollars a year, the State of Maryland has recently passed laws forbidding the discharge of sewage into the Chesapeake Bay or its tributaries without first purifying it. This has brought the city face to face with one of the most stupendous engineering projects of modern time—*i. e.*, the installation of a storm-water and a



VIEW IN ONE OF THE GREAT SIPHONS OF THE BALTIMORE SEWERAGE SYSTEM (SEE PAGE 367)



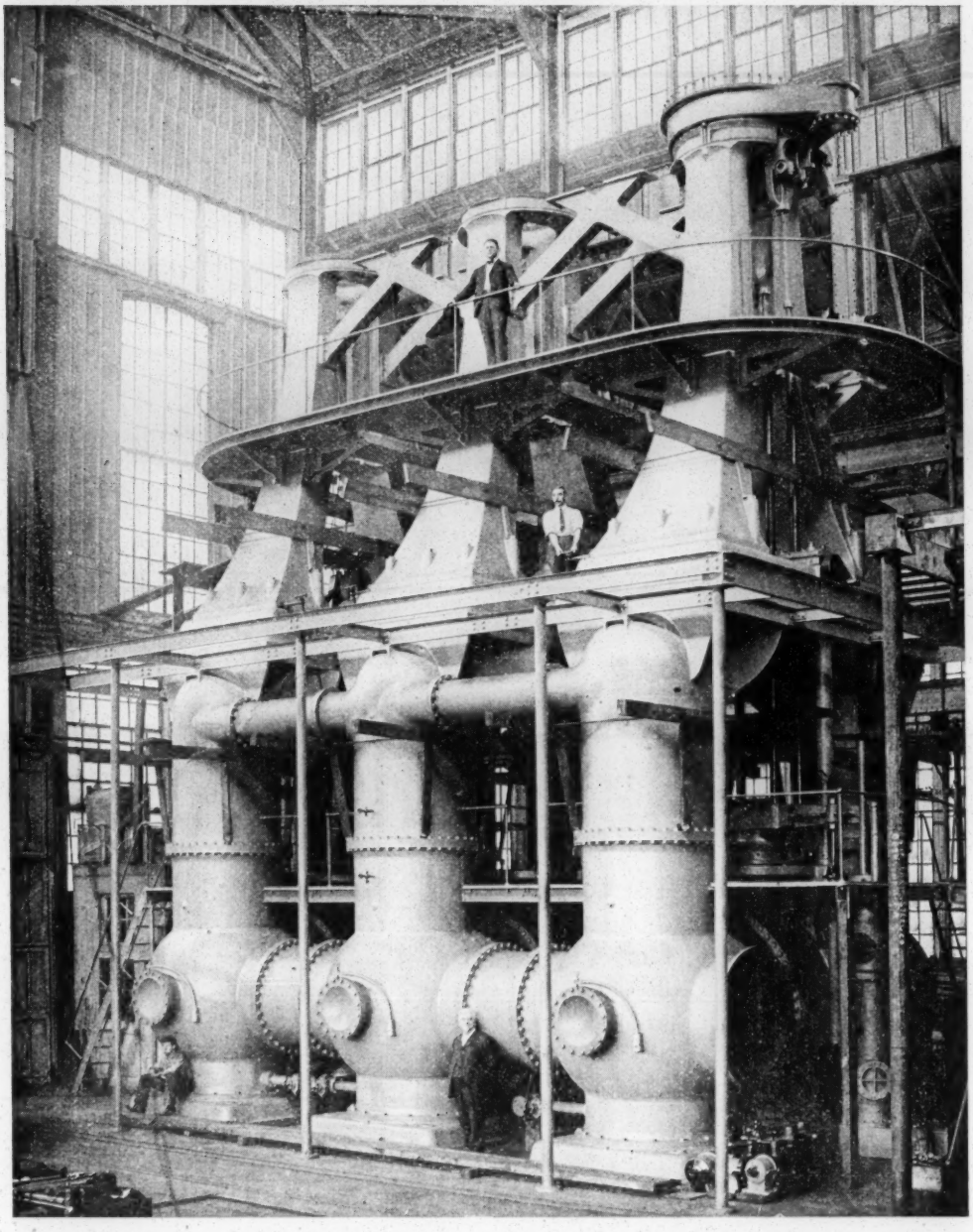
SHEATHING OF A DEEP TRENCH

sanitary sewerage system throughout the streets and alleys of the entire city, carrying connections to each individual house. This public work is being handled on a very broad scale, and is being pushed to completion in a most rapid and business-like manner.

The city expects to spend about $20,000,000 in disposing of the storm-water drainage and carrying the sewage to great disposal plants, in which the sewage will be brought to a state of purification equal to drinking water before discharging it into the Chesapeake Bay. In carrying out this great project, some of the sewers are of such size as to remind you of the ones in Paris.

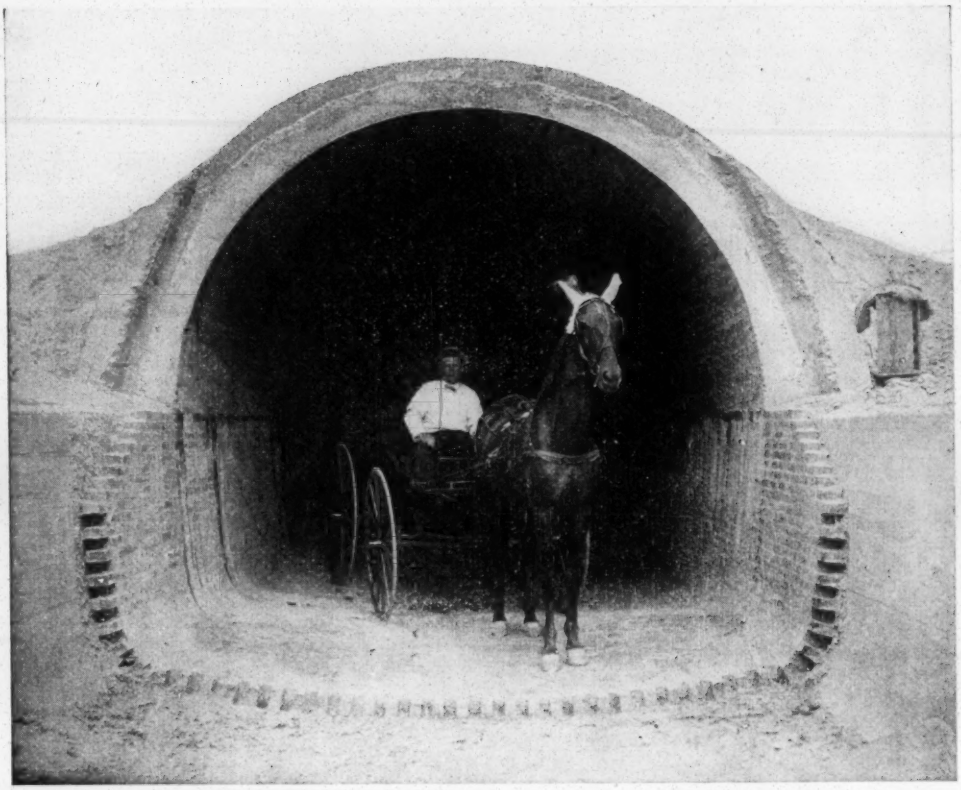
In order not to have to purify the storm-water that falls, two systems, one for storm-water and one for sanitary sewage, are being constructed, amounting in all to about 1,100 miles in length. This is some cases causes two large sewers of the different systems to come together on the same level, necessitating the siphoning of one beneath the other. The photograph on page 366 shows one of the largest siphons in the world, constructed along such unique lines as to have caused wide comment in the engineering world.

The great trouble with siphons is brought about by having to make the siphon large enough to take care of a heavy cloud-burst and still be operative during the summer flow, when there is a mere trickle, causing deposits to accumulate in the siphon. In this case a battery



ONE OF THE FIVE 27,500,000-GALLON PUMPING ENGINES TO BE INSTALLED IN THE SEWAGE PUMPING STATION

Elevation of engine No. 1 without steam cylinders; height of top cylinders, 48½ feet; weight of each engine, 1,400,000 pounds



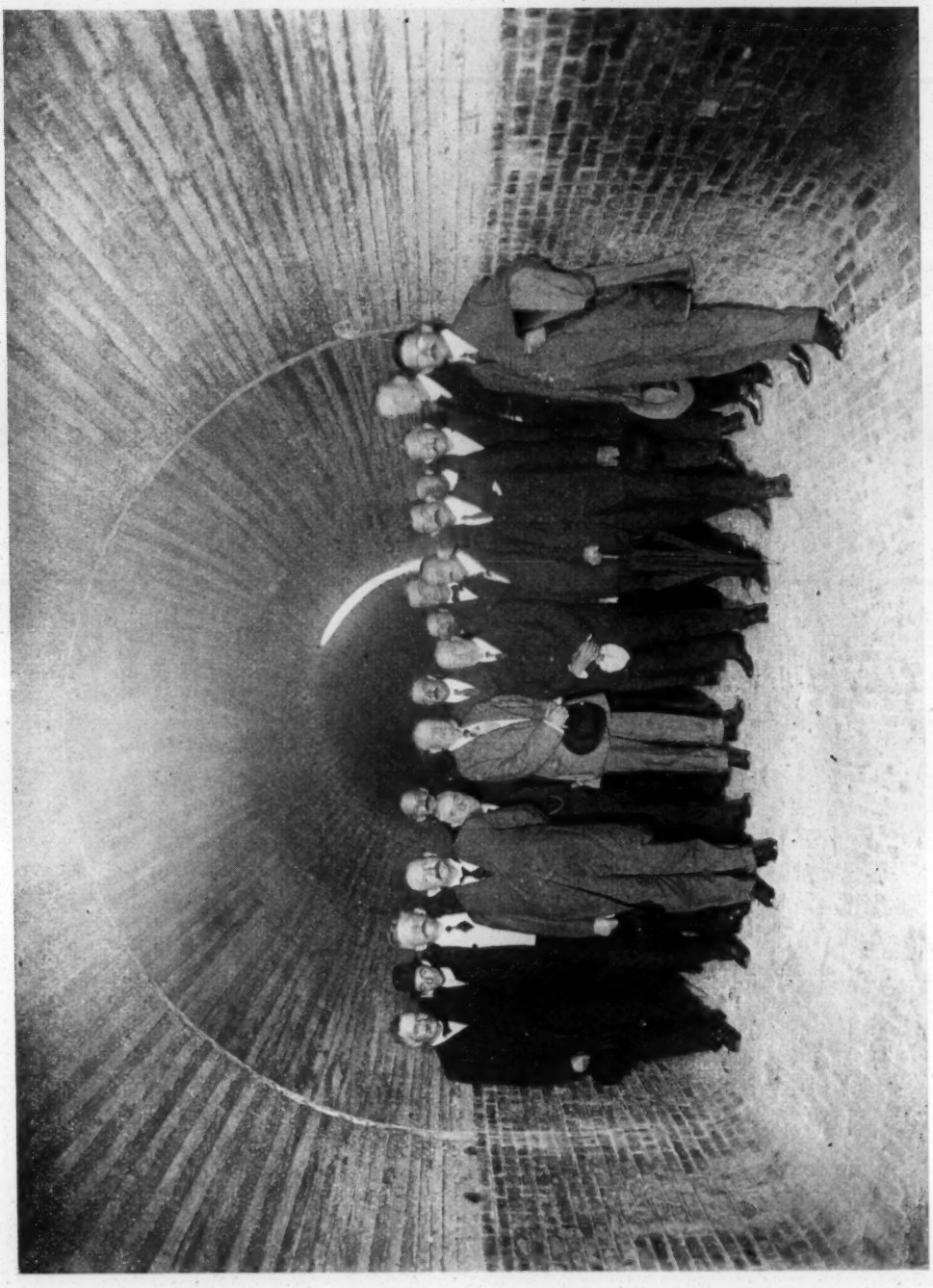
A COMPLETED SECTION OF THE OUTFALL SEWER

of pipes is used in connection with dams, the small pipe being for the summer flows, which keep it under pressure. Should a rain cause the flow to increase, it rises over a dam, discharging into a larger pipe, with still another pipe in reserve, with a higher dam to take care of a cloud-burst, thereby putting all the pipes under pressure, scouring them out by the water in the reserve order, until the flow is back in the small pipe, which pipe is under constant pressure by the dry-weather flow.

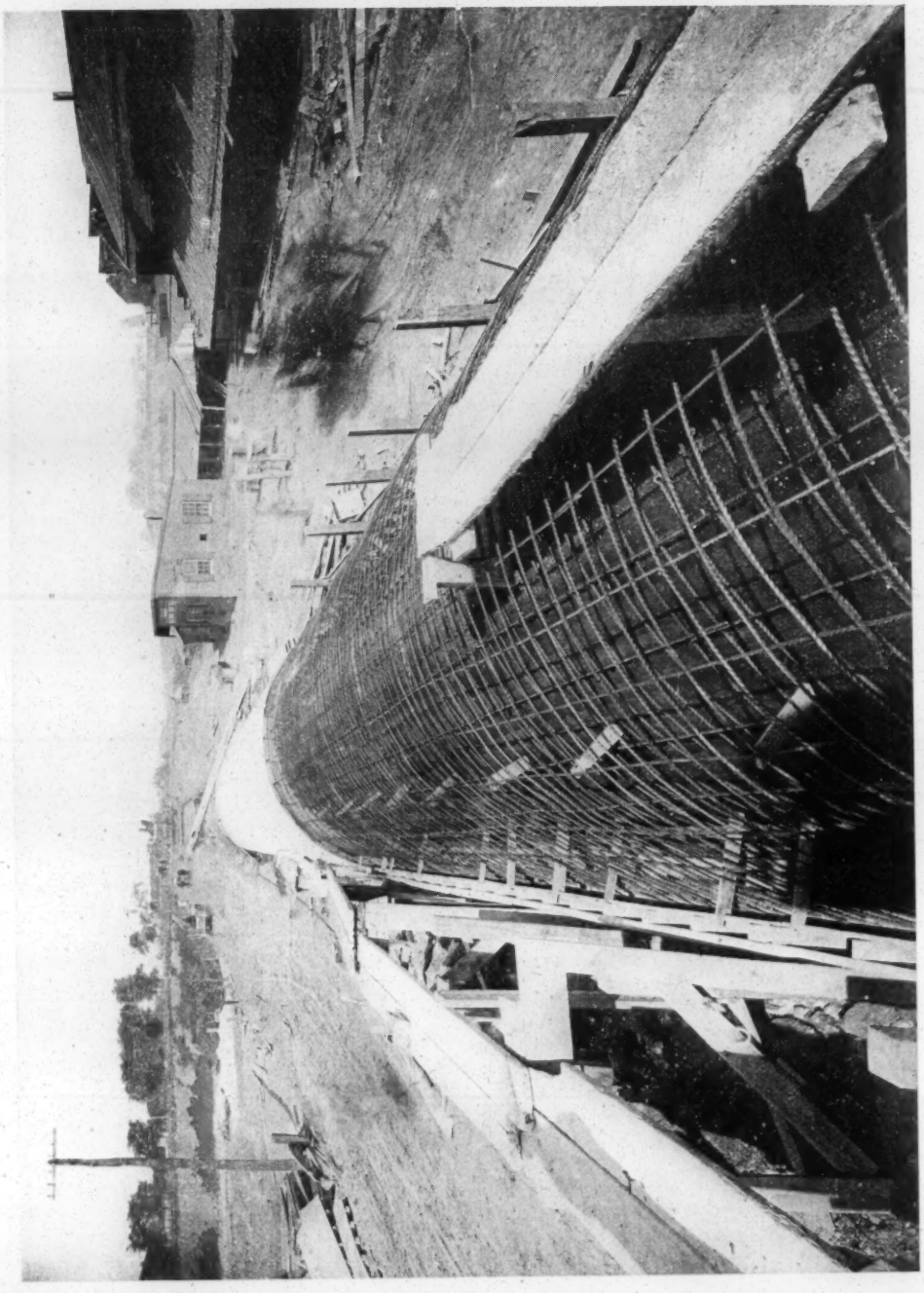
Concrete is being used to a great extent, and wonders are being moulded under the city with this concrete construction.

The storm-water flows directly into the harbor or to Jones' Falls, a stream passing through the city.

Two-thirds of the sanitary sewage of the city is intercepted by what is called the high-level intercepter, and is carried by gravity to the disposal works located on Back River. These works, when completed, will be capable of treating 300,000,000 gallons a day. The sewage from the other third of the city, lying around the harbor and below the high-level intercepter, is carried to a pumping station by an east and a west low-level intercepter. There the sewage is lifted from about 13 feet below tide, a height of 72 feet, including friction, by huge pumps, each capable of lifting 27,500,000 gallons a day. The photograph on page 368 shows one of the five pumps to be installed, now under construction. These pumps lift the sewage through iron force-mains to the high-level intercepter, whence it flows by gravity to the disposal plant.



THE GOVERNOR OF MARYLAND, THE SEWERAGE COMMISSION, AND PARTY OF FINANCIERS ACCOMPANYING CHIEF ENGINEER HENDRICK ON A TOUR OF INSPECTION (VIEW TAKEN IN OUTFALL SEWER)



ANOTHER VIEW OF THE OUTFALL SEWER, SHOWING THE METHOD OF REINFORCING

The method of treating the sewage at the disposal plant consists of hydrolitic tanks, sludge-digesting tanks under still water, stone sprinkling filters at a lower level, consisting of beds of broken stone 8½ feet deep, over which the sewage is distributed by means of sprays, then by under drains is carried to settling basins at a still lower level, and thence into Back River, coming out practically pure water.

Between the settling basins and the river into which the effluent is discharged there is a fall, which is utilized to generate electricity used to run pumps and other machinery for various uses throughout the plant.

Baltimore, in one respect, reminds one of Rome, the City of Hills, and in another respect it reminds one of Pompeii as she lay looking out over her beautiful bay under a mild climate, the people coming and going. When the attention of the citizens of Pompeii was called to the dangers of smoking Vesuvius near by, the answer would be: "It has never given us any trouble, so why should we worry?"

Just as the attention of the people of Baltimore has been called to the lack of sanitation, the reply has been: "It has never given us any trouble; why should we worry?" The Pompeiians were not as smart as the Baltimoreans—they did not awaken to a realization of their danger until too late, while the Baltimoreans have risen to the occasion by preparing before an epidemic should compel them to do so. The people of Baltimore have been sleeping and working over a volcano which, if once started, would make the city stand out before the world in a manner similar to that of 1904; but in the place of fire it would be epidemic.

Beneath the surface there is an underground air which investigation has proved is almost as ceaseless in motion as that in which we move. Whenever the ground becomes heated it streams out through the myriad pores of the earth's surface into the sunshine; when the ground cools, back through these pores rushes the aërial air. Every wind that sweeps the surface moves the air beneath in great volumes. With every rain it is driven deeper down. The movement of this buried atmosphere is slow, because it must find its way around myriads of soil particles which block its path, but it is of great extent and importance.

It is reasonable to suppose that with thousands of septic tanks filtering into the subsoil of a city for years and years this under-ground air would, in the course of time, grow foul. Each year this would grow worse and worse, until there would be a breaking point.

The men who were far-sighted enough to rouse the people of Baltimore from their slumbers and begin this great work before it was started in another way deserve a monument to their memory. I do not know of a single instance in history where a city the size of Baltimore has at one single stroke attempted to sewer the entire city, treating its enormous sewage by the most modern methods, both as to disposal of its storm water and purifying its sewage almost to drinking water.

In the sewerage system being constructed in Baltimore every known latest improvement is being used, besides numerous improvements which have been designed by the engineers of the commission.

One of the greatest difficulties encountered has been the vast number of under-ground obstructions beneath the streets of the city.

In a recent address made to the Society of Civil Engineers in Washington, D. C., I stated that the sewage problem as a world factor is forcing itself to the front very rapidly, and our country is approaching a point where it will have to deal with the sewage question on a broad scale. As rivers run from one state to another, the states cannot deal with the problem without clashing, and it will soon have to create a National Sewage Board similar to those abroad.

We have heretofore, on account of the vastness of our country and the size of our rivers, simply disposed of the sewage in the most economical manner at the

time, regardless of results, such as dumping it directly into lakes and rivers. This has been a short-sighted policy from the fact that large expenditures have been entered into in the way of sewers, which will necessarily have to be readjusted in order to conform to sanitary laws now being passed requiring the treatment of sewage before discharging it into rivers or lakes.

The city of Baltimore is showing the same progressive spirit in handling this great sanitary problem that she has shown in many other enterprises of world-wide interest, causing cities all over the world to send committees and engineers to study the plans and methods of prosecuting the work, which in magnitude, character, and rapidity of execution stands unequaled.

THE WORLD'S MOST CRUEL EARTHQUAKE

By Charles W. Wright

Of the United States Geological Survey

Mr Wright was sent to the region of the recent Sicilian earthquake by the National Geographic Society to make such study and investigations as a week's stay at Messina and Reggio would permit.

An earthquake such as the recent one at Messina is a catastrophe of the first magnitude. It will be recorded in history as one of the world's greatest disasters, though viewed geologically it represents a sudden displacement of probably only a few inches in the earth's crust and is of less importance than other earthquakes during the last decade.

As a geologist I have always had a desire to witness the results of an earthquake, if not at the time of occurrence, then directly afterward, so as to see not only the geologic changes, but the vast destruction to the surrounding country, as well as its effect on the inhabitants. So the opportunity to visit Messina through the courtesy of the Board of Managers of the National Geographic Society was gladly accepted.

I reached Sicily the middle of February and spent a week there. No accommodations being available in Messina, it was necessary to go to Taormina, just an hour's ride by train, and a remarkable contrast it was to leave the dust and desolation of the fallen city at sundown for the most glorious garden spot in all Italy.

Before discussing the disaster, however, let us first glance through our Baedeker to learn something of the cities and their population; also of the industries and commerce of this part of the Mediterranean.

Those who have been fortunate enough to visit the north of Sicily will remember the indescribable charm and fascination of that entire section. Towering peaks rise from each side of the straits of Messina to elevations of 4,000 to 6,000 feet, and dissecting their gradual sloping sides are canyon-like valleys which broaden into wide flats at tide water. On these gravel flats, or benches, above sea-level the cities of Messina and Reggio are situated, and higher up the valleys many villages are scattered. In these valleys and on the flanks of the hills orchards of lemons, oranges, and pomegranates are cultivated; also almond trees and vineyards, which, when in blossom, refresh the whole land with their fragrance.

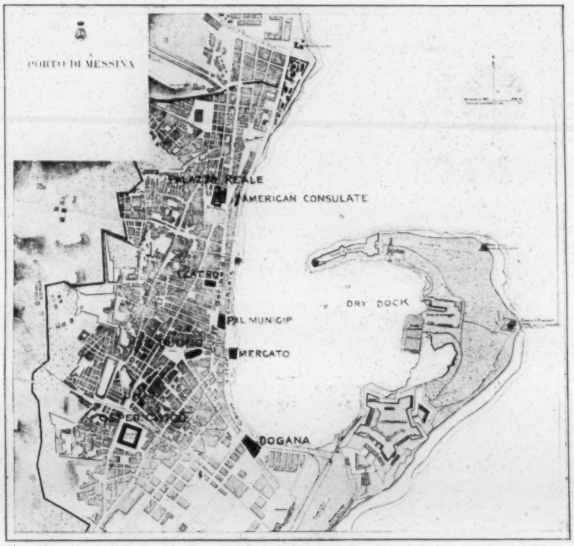
MESSINA IS THE BEST HARBOR OF ITALY

Messina, now known to the whole world, is a large seaport town in the northeast corner of Sicily. The approach by steamer is of remarkable beauty, the

GENERAL VIEW OF MESSINA BEFORE THE EARTHQUAKE

Showing the sickle-shaped harbor, "the largest and safest in the kingdom of Italy," the straits of Messina, and the coast of Calabria in the distance

city rising amphitheater-like from the sea with a dazzling whiteness of houses along the water front, which present a picturesque contrast to the dark, rocky hills capped with castle ruins and forts in the background. The harbor, which is shown in the general view of Messina, is the largest and safest in the kingdom of Italy. It is over 30 fathoms deep, spacious, well furnished with quays, and defended by a fort and citadel. As many as 5,000 vessels call here annually, bringing wheat, cotton, wool, hardware, etc., and taking away cargoes of lemons, oranges, almonds, silks, wine, essence, oil, etc.



SKETCH OF MESSINA

Showing principal buildings, the city wall, and sickle-shaped harbor

In the city itself, which contained about 150,000 inhabitants, were several wide, handsome streets, including Corso Garabaldi, Cavour, and Vittorio Emmanuele, all of which are paved with granite blocks and ornamented with statues and fountains. Interspersed between the houses or occupying prominent corners were over fifty churches—the most ancient being the Duomo—a Palazzo Reale and Palazzo Municipali; also a large hospital (Ospedale Civico), a custom-house, (Dogana), and a theater in which Aida was sung the night before the catastrophe. It was a live city, the harbor and pier being usually full of boats and people, and every hour brought a trainload of freight to be ferried across the straits or loaded direct for shipment to foreign ports.

Its historical record of over 2,000 years includes bombardments during the Punic and Roman civil wars; also by the Goths and Saracens; a loss of 40,000 inhabitants by plague in 1740; an almost complete destruction by earthquake in 1783, with a death roll of 29,515 and property loss of $26,000,000; another bombardment in 1848 and another loss of 16,000 by cholera in 1854. In a memoir by Deodat de Dolomieu, published in 1784, this earthquake is described as follows:

"The destructive shock of February 5, 1783, was sudden, instantaneous; nothing preceded it, nothing announced it; it broke forth and destroyed at the same moment; it did not give time for flight; . . . a larger part of the misfortune of Messina can be attributed to the lack of solidity in the structure of the buildings."

Both of these and many more of Dolomieu's statements are equally descriptive of the recent disaster. Subsequent violent earth tremblings occurred in 1894 and 1896, the last important one being on September 8, 1905, and causing a death roll of 529.

On the opposite side of the straits is Reggio, a seaport of Calábria, 10 miles southeast of Messina. It, too, was a flourishing, opulent city of 45,000 inhabitants, with spacious streets and beautiful buildings and a history similar to that of Messina. Scilla, Faro, San Giovanni, Catona, Pellaro, Terresa, and Scallita are other towns which border this luxuriant shore-line and which also suffered destruction.

CORSO VITTORIO EMMANUELE LOOKING NORTH ALONG WATER FRONT IN MESSINA
Showing the local displacement of the quay, even below water level, and the destruction of the famous Palazzata, "the pride of Messina"

VIA PELLICANO LOOKING SOUTH ALONG WATER FRONT IN REGGIO
Showing destruction to buildings and temporary quarters of inhabitants. In the foreground lies a grand piano among the ruins

THE CATASTROPHE CAME WHEN EVERYONE WAS ASLEEP

The earthquake occurred on Monday morning, the 28th of December, at 5.23, while it was still dark and most of the inhabitants of the unfortunate towns were still sleeping. It came without warning; the shock was intense and widespread; it lasted 35 seconds, and during this small space of time most of the stupendous destruction of life and property took place. For several weeks preceding it slight shocks were felt in the vicinity of Messina, and subsequent shocks of considerable magnitude occurred on January 2, at 9.40 p. m., and January 5, at 12.10 p. m. The intensity was greatest at the north entrance to the straits, and its amplitude became rapidly less with increasing distance from this central point.

The vastness of the catastrophe in loss of life has hardly a parallel in the history of earthquake tragedies, and it is difficult indeed to conceive such an overwhelming disaster in so short a time.

The submarine cable was broken and all telegraphic communication was cut off, so that the first news of the disaster was dispatched at the time by one of the torpedo boats lying in the harbor. It immediately got up steam and raced up the Calabria coast to find a telegraph station intact, where the tale might be told and the call for aid given. All this took time, and it was night before Rome learned of what had happened in the southern portion of her peninsula.

The terrible news then traveled to all parts of the world, but they were only first reports and believed by most readers to be much overestimated. Headlines then appeared in the newspapers giving impossible accounts of the disaster; the whole coast line was reported to have been altered and adjacent towns swept away; it was said that deep chasms appeared in the city streets; that entire areas were overturned; roads and railways twisted and bridges uprooted. A grand eruption of Etna and the disappearance of the Æolian Islands were also vividly pictured and the subsequent tidal wave and destruction by fire exaggerated.

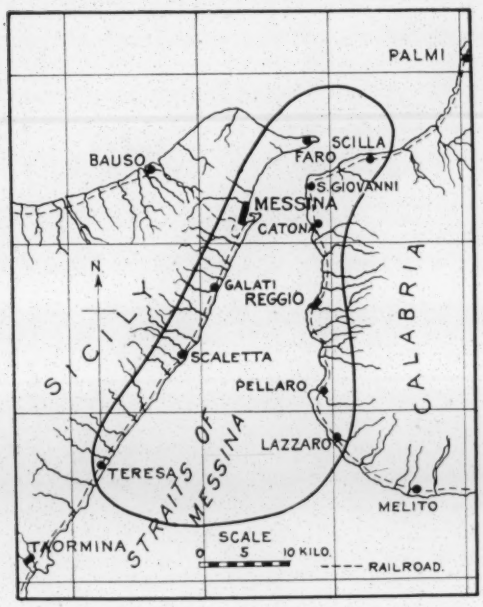
But in view of these mythical statements, that of the great destruction of people, the most heartrending of all, was, alas, not falsely reported. Though it is not possible even now to state accurately the loss of life, it is probable that the death roll of Messina alone will reach 100,000, that of Reggio 20,000, and of San Giovanni and other villages 30,000.

One survivor told me that he was suddenly awakened by a loud rumbling, with the sensation of being lifted up and swayed back and forth in the air, only to be let down again by jerks and jars. Another, who was on the street at the time of the earthquake, said that he first heard a low, whistling sound in the distance, which gradually grew louder and louder, and finally broke forth into a roar. The earth seemed to move in all directions at once, and it was impossible to stand.

Soon after this bewildering blow, which was accompanied by thunder-like rumblings of the earth and the crushing noise of falling towers and buildings, a dead silence spread over the city, only to be broken later by the shrieks of the wounded. It was pitch dark, and even the corner street lights were extinguished because of a breaking of the gas pipes. It was raining and a southeast wind was blowing. The uninjured rushed to the streets, but knew not which way to turn, and stood about helpless and often without clothes.

THE TIDAL WAVE WAS NOT PARTICULARLY DESTRUCTIVE

Directly after the shock the sea receded a short distance from the shore, but soon advanced again in the form of a foaming tidal wave 8 feet high at Messina and 12 to 15 feet high at Reggio. At Messina it washed over the neck of land forming the harbor, destroying the breakwater, leaving small boats stranded high above the shore-line and dashing a Russian steamer of 2,000 tons from its berth in the dry dock back into the bay,



SKETCH MAP SHOWING AREA OF MAXIMUM DESTRUCTION

where it sank. It flowed over the city quay, washing away small cargoes of freight and many crates of lemons, and even extended into the buildings along the water front. A few people who happened to be along the quay at this early hour were hurt, and it is possible that some were carried away by the water.

At Reggio still greater damage was done by the waves. Freight cars standing ready to be ferried across the straits were overturned and the wharf wrecked even more seriously than at Messina. Leaving this immediate area, the wave traveled southward to Taormina, Catania, and Syracuse, even reaching Malta, where it arrived 115 minutes after the earthquake.

Fire also broke out in several places about Messina, being caused principally by the breaking of the gas pipes, but there was little to burn, so that this terrible agent of destruction, so evident in the San Francisco earthquake, had a remarkably poor field to gain headway. The Palazzo Municipale, the Hotel Trinacria and other buildings scattered about the city caught fire and smouldered for a while, but were soon extinguished by the rain, which drizzled for the first few days after the destruction.

THE AREA OF DEVASTATION

The area of maximum destruction, as indicated on the accompanying map, extends from Terresa to Faro, on the Sicilian side, and from Lazzaro to Scilla, on the Calabrian side of the straits. In all, about 20 towns and villages were wrecked to a greater or less extent. Within this area, however, the damage was not uniform, as many villages up the valleys, and even some along the coast, were only slightly affected.

In the cities of Messina and Reggio rows of houses are standing which at first sight appear to have been saved, but behind these façades they are a total wreck. Probably the best example of this is the beautiful Palazzato, which was the pride of Messina. On the other hand, some buildings are only deprived of their front walls, leaving exposed to view the interiors of the rooms with overturned chairs and wall pictures slightly out of adjustment. Libraries, manuscript, letters, all kinds of furniture, including grand pianos and oil paintings, lie scattered throughout a débris of rubble and plaster, and buried beneath it all lie the bodies of those who gloried in these possessions.

The shock, of course, was felt at Taormina, Catania, Palermo, Syracuse, and other towns within a hundred-mile radius, awakening and frightening the inhabitants, but the buildings themselves were not damaged. Nevertheless, the effect of the earthquake on the beautiful cities of Sicily, dependent as they are on the tourist trade, has been great, for it has deprived them of one of their means of livelihood. The world of travelers has been frightened away from this glorious island at this critical moment when it needs them most. The hotels are empty and the guide or cabman cannot earn his lira nor the flower girl her soldo.

WORK OF RELIEF AND AID TO SURVIVORS

The torpedo boats and the battleship *Piemonte* of the Italian fleet were in the

VIA GARIBALDI, A PROMINENT STREET IN MESSINA, LOOKING NORTH

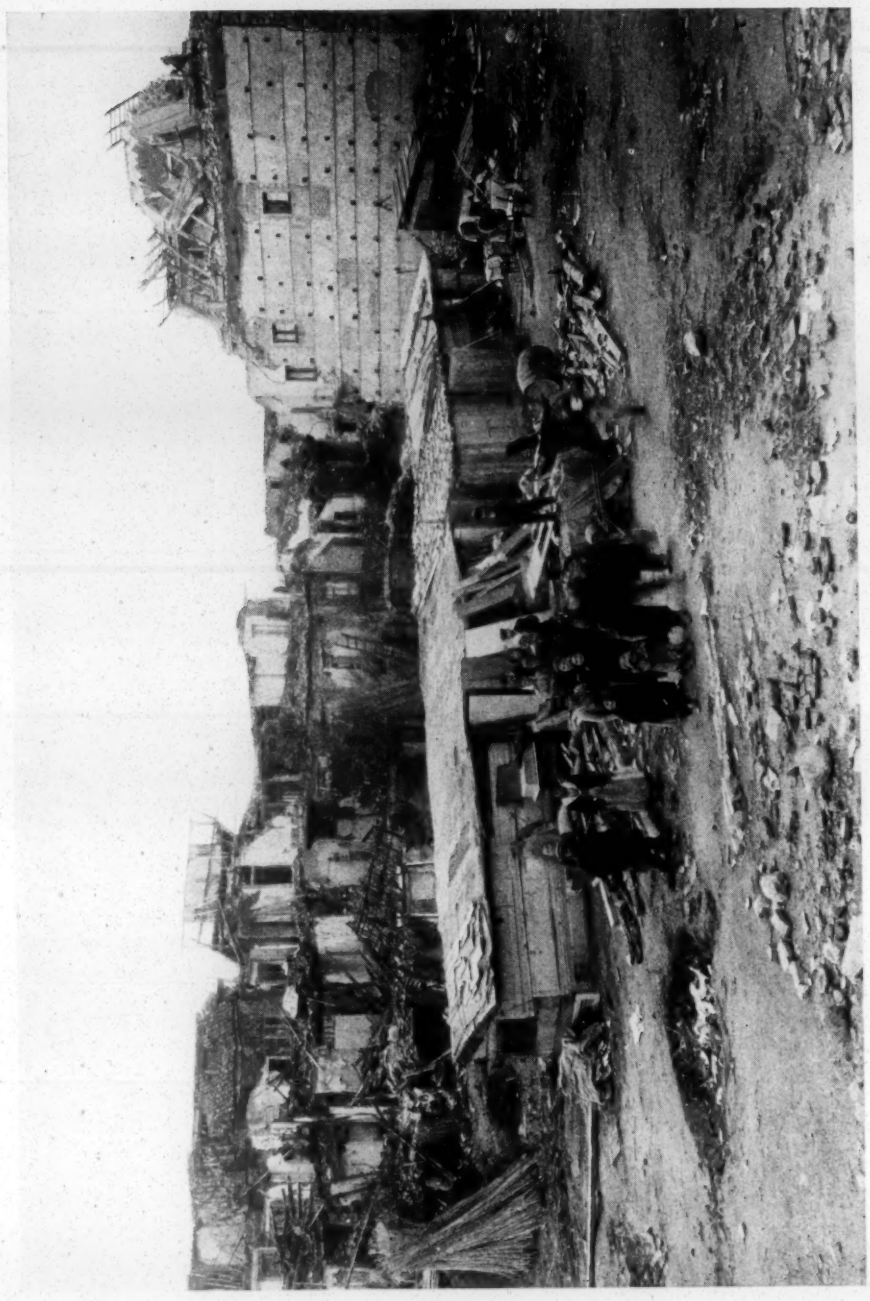
On the left is the Bank of Sicily, in which 75,000,000 francs were said to have been on deposit. An attempt was made to rob the bank just after the earthquake and one window shows where its bars had been forced open, but the safe with its treasures could not be broken into by the thieves. The money was recovered by soldiers later.

SCENE ALONG VIA PRIMO SEPTEMBER, MESSINA, SHOWING SOLDIERS IN CHARGE OF EXCAVATIONS

All valuables found are noted and placed in boxes, which are labeled by street and house number so as to be delivered later to the proper claimant

PIAZZO SAN LEO LOOKING WEST AND SHOWING TOTAL DESTRUCTION OF MANY BUILDINGS: MESSINA

"Thus they collapsed amid suffocating clouds of dust into a hideous conglomeration of rubble, mortar, and furniture, forming regular dead-falls for man"



SCENE IN REGGIO SHOWING SURVIVORS AND TEMPORARY QUARTERS
Their homes are in the background

INTERIOR VIEW OF THE DUOMO AT MESSINA SHOWING TOTAL COLLAPSE

Everything in the church was buried deep under timber and tile, even the large bronze bell, though the altar and sanctuary remain intact

THE HOSPITAL IN WHICH 200 PATIENTS PERISHED

INTERIOR OF DUOMO AT MESSINA SHOWING ROW OF SAINTS, SOME HAVING BEEN THROWN OUT OF THEIR BERTHS BY THE SHOCK

Beautiful columns of granite and porphyry lie in the foreground

INTERIOR OF SAN PAULO CATHEDRAL, SHOWING SOME MASTER PAINTINGS WHICH WERE SAVED

Many art treasures, of which Messina had its share, were destroyed. Of the 50 churches in Messina, only one remains standing

BOX COFFINS, EACH CONTAINING THREE BODIES, READY FOR BURIAL IN CEMETERIE INGLESIE

Under the mound on the right 7,000 bodies are said to be buried

harbor at the time of the earthquake, and their crews, with the few panic-stricken soldiers of the city, were the first to lend assistance to Messina. The next morning at daybreak the *Theropia*, a North German Lloyd boat, sailed into the harbor and soon after it came the Russian warship *Admiral Makaroff*. The crews of both ships turned immediately to the task of rescue, and that afternoon the *Theropia*, laden with wounded and refugees, weighed anchor for Naples. On the 30th the English man-of-war *Sutlledge* and others were dispatched from the fleet at Malta to join the rescuing parties, and Italian warships were sent from Naples and Sardinia. The sailors were organized in small gangs with an officer in charge and worked quickly and heroically, some losing their lives in the endeavor to save others.

Help did not arrive at Reggio until two days after the disaster, its fate being unknown even in Messina, as both telegraphic and railway communications were destroyed.

Twenty-four hours after hearing of the calamity the King and Queen of Italy departed for this scene of disaster, and their presence alone gave courage and hope to the distracted, while their personal assistance in relief work inspired others to do their utmost to succor the wounded and starving. Troops were also sent in from Catania, Palermo, and from the mainland as far north as Genoa, but without sufficient food supply for themselves, and many suffered because of it, though all showed courage and endurance. Hardly a building was left in Messina fit for shelter, and the rain and winds added much to the severity of the suffering. As every minute meant a life, all else save rescue was neglected, even to the burying of the dead, and both sailor and soldier worked far

into the night, often without food or shelter. The wounded were removed from the city as fast as possible by boats to Naples and by train to Palermo and Catania, where they were cared for in the hospitals, hotels, and private houses.

Systematic relief work was not inaugurated until a week after the misfortune, when the city was divided into three sections, each in charge of a detachment of soldiers, who camped in the public parks. Food and clothing were distributed to the survivors belonging to each section, but the main work of the soldiers was to assist in digging out those still under the ruins alive, and, worst of all, to guard the places and people against thieves. The earthquake opened the prison doors, and many of Italy's greatest criminals were liberated. They immediately set to work robbing the dead and the dying, so as to leave the city with full pockets. This shameless looting was soon put to an end when the soldiers were in full charge, the offenders being shot on the spot. Dozens of such thieves are said to have been killled.

In regard to the survivors, it is said that they behaved like children, running about the streets, aimlessly seeking food, and too stupid to leave the town for the country, where they could have found both food and shelter. One of the striking features which I could not help noticing was the apathy of the sufferers, their dazed expression and amazing resignation. Many doubtless are bearing their sorrows bravely, but some seem to be mentally benumbed.

Little of the actual suffering will ever be known, and lucky were those who were instantly killed. As some were brought alive out of the ruins after two weeks, there were many probably who withstood torture and starvation for at least a week before they were relieved by death.

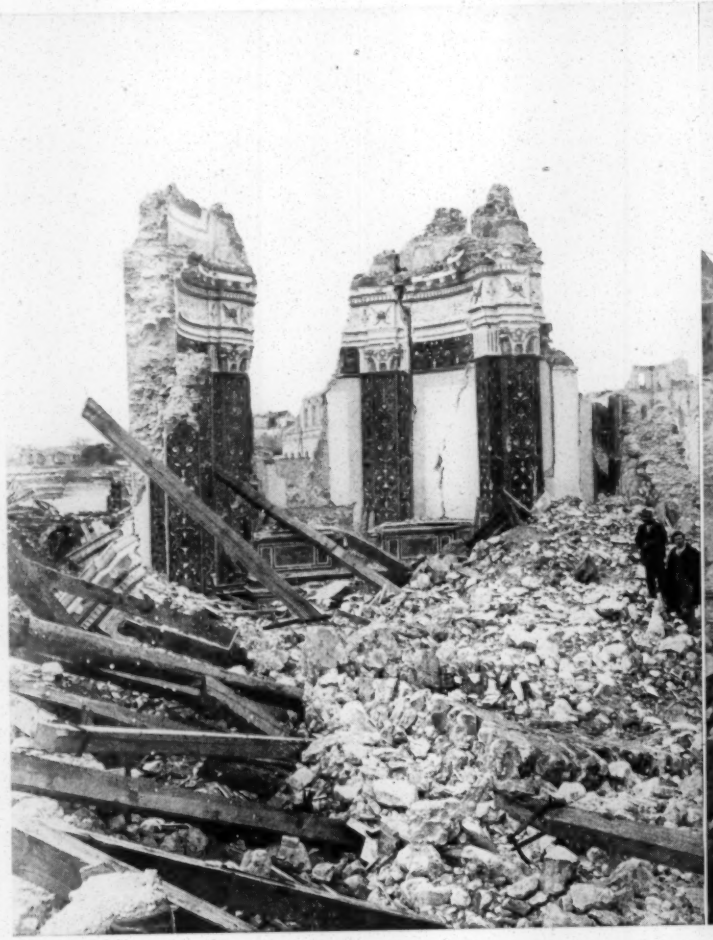
BURIED ALIVE FOR 18 DAYS

Francesco Minissale, a young lad of ten, shown in the picture on this page and his two sisters, Giovannina and Nataline, 14 and 16 years of age, probably had the most remarkable experiences of any survivors. It was my pleasure to meet them on board a freight steamer through the kindness of its captain. This is their seemingly incredible tale:

FRANCESCO, THE LAD WHO DUG HIMSELF OUT OF THE RUINS OF MESSINA, WHERE HE AND HIS TWO SISTERS WERE IMPRISONED FOR 18 DAYS

"We were sleeping in a large room on the ground floor. Our house collapsed, killing our mother and imprisoning us. Providentially, in the same room there was food which we had purchased for the New Year's feast—figs, cookies, a bag of onions, a bottle of vinegar, and besides these there was a small barrel of water into which a large bottle of oil had tumbled and been broken, but the oil was not lost. On these provisions we lived, but were never very hungry. Fresh water and fresh air were what we wanted most. The room was quite dark, and although we were there for 18 days it hardly seemed more than four. Finally Francesco began pounding the plaster wall with a cobble-stone, breaking it down bit

THE TOMBS OF CAMPO SANTO JUST SOUTH OF MESSINA WHICH WERE OPENED BY THE EARTHQUAKE



CATHEDRAL IN REGGIO SHOWING TOTAL WRECKAGE
This church was noted for its beautiful mosaic decorations

ROOM IN WHICH THE AMERICAN CONSUL, DR CHENEY, AND HIS WIFE, WERE KILLED

A SACRED TOMB IN THE DUOMO OF MESSINA WHICH WAS NOT SPARED BY THE EARTHQUAKE

by bit, until there was an opening large enough for him to scramble through into the adjoining room and up over the debris to the surface, where he was hailed by an officer. He told his incredible tale and we were all rescued."

Their father was in New York at the time, and after learning of their safety he wrote that he would start on the *Republic*, the fate of which they learned later. They had not had further news from him, but anticipated his arrival every day. Each survivor had his own tale of woe, and many of these have been presented in recent magazine articles.

A great sorrow, but not one of suffering, was the death of Dr and Mrs Cheney. The search for their bodies was begun by Italian soldiers, who were relieved later by American sailors. Both bodies were found on January 15 in bed, and death had evidently been instantaneous.

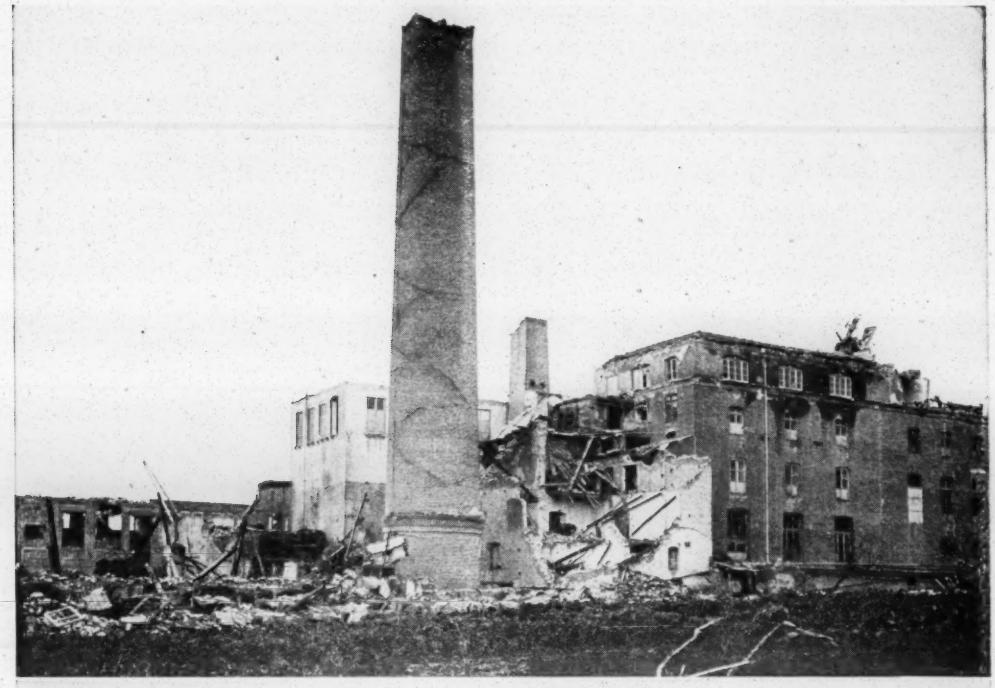
Though the American war ships did not arrive in the vicinity of the earthquake until January 10, somewhat late to lend any great assistance, still the effect of the sympathy expressed by the President, the magnitude of the sum appropriated by Congress, the prompt offer to send the fleet under Admiral Sperry to Messina, the activity of Ambassador Griscom in the relief work in Rome and that of the American Red Cross, all inspired creditable comment in the Italian newspapers and gratitude in the hearts of the people.

Since the day of devastation the Italian army has done noble work in accomplishing the task before it, and both the soldiers and sailors deserve great credit for their bravery and endurance.

COMPARISON WITH THE SAN FRANCISCO EARTHQUAKE OF 1906

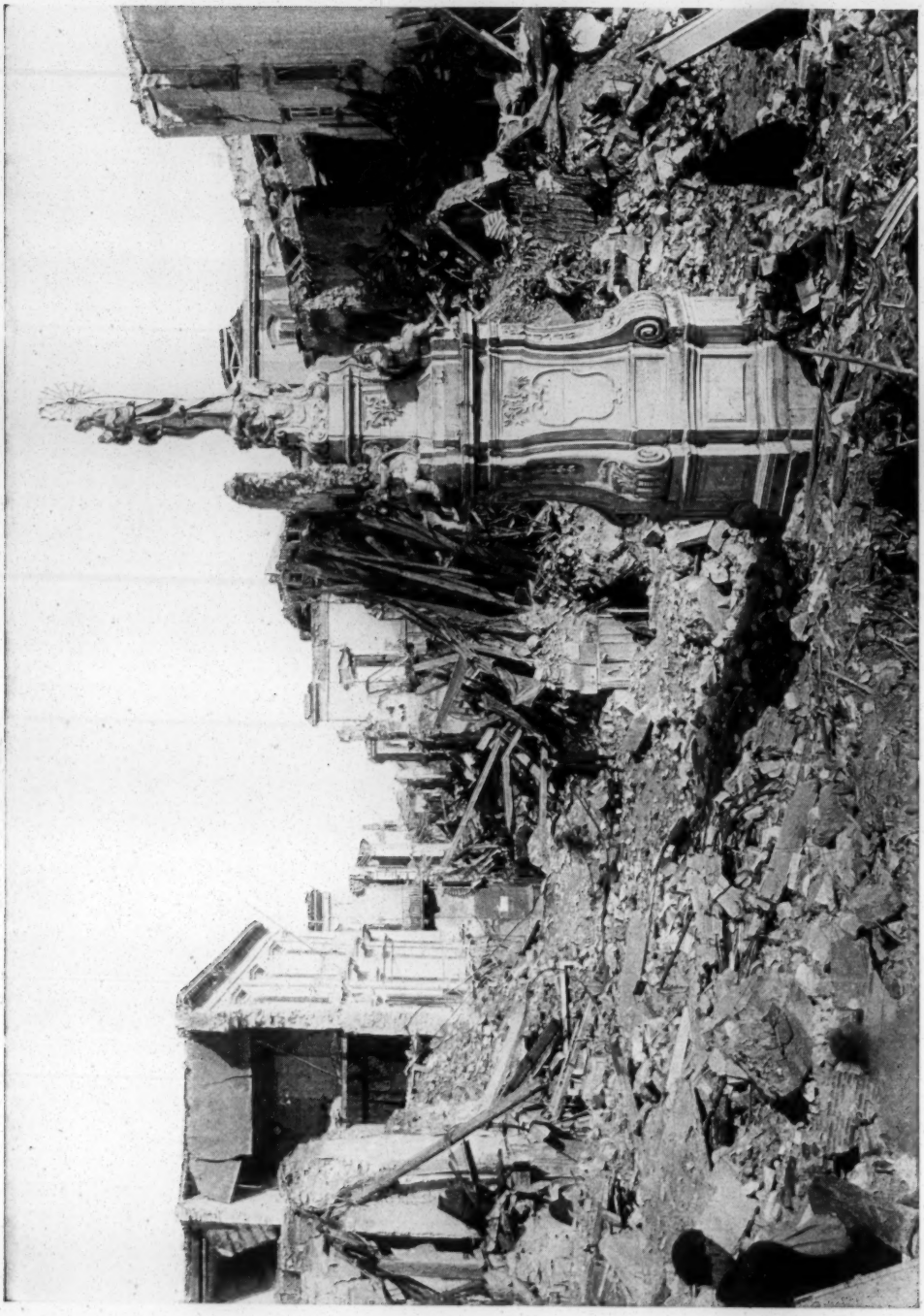
In San Francisco the earthquake caused little loss of life from falling structures and the houses left little debris. The main problem was fire-fighting, securing order and safety of life and property, supplying food and water to 350,000 and shelter to 175,000 people. Telegraphic and railway communications were not destroyed and notification of disaster to the rest of the world was prompt. The army and navy in and near the city were unhurt, and with them supplies were made available and promptly distributed.

At Messina and Reggio the initial shock caused the principal damage, and the loss of life was due mainly to falling structures, the loss by fire being unimportant. Telegraphic and railway communication was cut off and assistance had to come by sea. The army and navy in the vicinity suffered heavily, Messina losing two-thirds of her garrison and all supplies. The problem was to rescue and care for the wounded, to establish order and safety to life and property, to dispose of the dead, and give food and water to the living, a tremendous task, indeed, when one views the vast area of destruction. Thus we find that while the buildings in San Francisco were more properly constructed to withstand shocks, those in Messina were better able to resist destruction by fire.



A FACTORY JUST SOUTH OF MESSINA
The top of the chimney was thrown to the southeast

PIAZZA DOGANA: MESSINA
"Some buildings are only deprived of their front walls, leaving exposed to view the interiors of rooms with overturned chairs and wall pictures slightly out of adjustment"



PIAZZA IMMACULATA AND CORSO CAVOUR, SHOWING A MONUMENT OF GOOD CONSTRUCTION INTACT AND BUILDINGS OF POOR CONSTRUCTION TOTAL WRECKS

WRETCHED TYPE OF BUILDINGS

Architecturally many of the buildings of Messina were superb, the effect of strength being emphasized by massive walls and columns. But when one investigates the details of construction and of material used both features are found to be deficient. A worse type of structure within an area frequented by earthquakes is difficult to imagine. The houses, which were from two to four stories high, were built of round cobbles or rubble cemented together with a poor mortar which is sadly lacking in strength; even the walls are not bound together, the cross-beams for a floor being set in rows of indentations left in the wall at the time of construction. On these cross-beams, which are often only wooden poles, the tiled floors are laid, and the roofs, too, are generally covered with heavy tiles. The effect of the earthquake is quite evident; the walls of the buildings cracked readily and spread sufficiently to permit the heavy floors and roofs to drop to the ground; the walls thus being freed, subsequent shocks caused them to tumble on top of the already partially wrecked building, completing its destruction. Thus they collapsed amid suffocating clouds of dust into a hideous conglomeration of rubble, mortar, and furniture, forming regular deadfalls for man.

HOW WILL MESSINA BE REBUILT

In the Italian Parliament a week after the disaster it was said that "Messina shall rise again." This bold proposition was applauded vigorously and initial appropriations were immediately made. But it is not enough to make propositions and endorse them with vigor. Over three months have passed since the disaster with no attempt to rebuild. A commission, consisting of seismologists, geologists, and engineers, was formed to determine the questions when, where, and how reconstruction could best be accomplished. They are still debating and it may be months before any definite steps will be taken. Messina is one of the essential ports of the world, both from commercial and military standpoints. Its strategic position, like Gibraltar, commands a ship's highway and in its harbor a whole fleet may hide in safety. Any one knowing its situation cannot doubt but that the risk will be taken and a new city built.

As to "when" reconstruction shall begin there is little difference of opinion, the answer being "as soon as possible." The first necessity will be to remove the present debris, which is estimated to amount to 1,000,000 tons. From this mass of wreckage there are still about 40,000 bodies to be recovered and buried before the place is even fit to live in. Thus to prepare the present site so that construction work could begin will take at least a year and probably longer.

The second question, "where," cannot be answered until careful scientific investigations of the entire area now in progress have been completed, and even then the selection of a site will necessarily be governed by the military and commercial requirements. I have heard suggested for a possible site the area just south of Gazzi, about 3 miles south of the harbor, as here the gravel bench is not deep and the buildings did not suffer as much damage as those at Messina. The slopes of the mountains where solid rock foundation occurs and where small villages were unhurt have also been suggested, but such a site would not be practicable from a commercial viewpoint. This selection of a new site is a perplexing task, and in the end the property-owners and the sentiment of the people may prompt the rebuilding of the city on its present location.

This second question decided, then the third, the most important of all, will have to be carefully considered. How should the city and towns along this unstable coast line be rebuilt? To begin with, the streets of the city should conform with the direction of the straits, which is said to be parallel with the direction of the seismic wave, for it was noted that buildings along streets which run diagonally to this direction were more greatly shattered. It was also noted that buildings

VIEW ALONG QUAY IN MESSINA SHOWING A DISPLACEMENT CAUSED BY LOCAL LAND-SLIPPING

of one and two stories were much less damaged than those of three and four stories, and that many houses were traversed by cracks running north and south.

To determine the character of the construction to be employed, the engineers have the reports on the San Francisco, the Japanese, and other earthquakes, which discuss fully the effect of an earthquake on all the varied types of structure. With these and their present knowledge of the structures in Messina there is every reason to believe that they will decide upon an individual type especially adapted to this region that will give great resistance to earthquake shocks. To the government will fall the duty of enforcing the use of this type of structure. With buildings properly constructed the destruction by earthquakes to life and property will be minimized, so that cities and towns along the straits will be much safer to live in.

WHAT EARTHQUAKES ARE

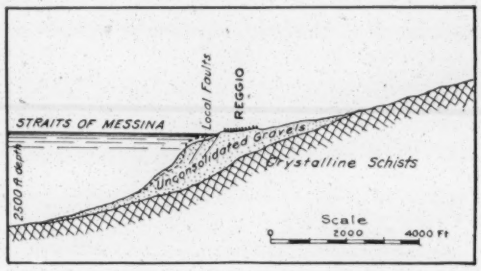
Earthquakes are tremors or shakings of the ground naturally produced. They are superficial phenomena resulting from a subterranean shock which is transmitted as an elastic wave through the material of the earth's crust. From points of initial disturbance these waves pass out in all directions. They are caused by volcanic explosions and accompany the development of mountain structure. With the contraction of the earth's crust and adjustment of land masses powerful strains, consisting of terrestrial pressure or tension, are developed, and wherever and whenever such strains suffice to overcome the elasticity of the rocks involved, either viscous flexure or rupture must result. A dislocation or tectonic earthquake, therefore, is simply the jolt or jar produced by a sudden movement of the crust along a fault

plane or system of planes and its sudden arrest. The sudden dropping of a section of the crust for only a few inches could cause excessive jarring of the ground. Earthwaves or undulations are caused by these jarrings, which are transmitted outward from the center or centers of disturbance. The rate of propagation is relatively fast through rock masses, but the waves are much impeded in rate and increased in amplitude when they traverse beds of gravel, sand, or clay. It is therefore found that the most destructive effects are confined to areas where the surface is occupied by unconsolidated materials, while on adjoining tracts, where solid rock forms the foundation, the buildings often escape injury.

The rock formations which constitute the mountainous masses of the Calabrian province and the northern part of Sicily consist essentially of crystalline schists and gneiss, intruding which are granitic rocks exposed in the northern portion of the area (see map above). The low lands and bottoms of the valleys, on the other hand, are occupied by slightly indurated shales and sandstones of Tertiary and Quaternary ages, and along the shore lines are bench deposits of unconsolidated gravels of recent age. In the vicinity of Mount Etna the area is covered by lava flows and tufaceous beds.

POSSIBLE CAUSES OF THE EARTHQUAKE

The Straits of Messina occupy a deep channel between the two ancient mountain ranges and are bordered by rock formations of relatively recent age. That isostatic readjustment between these two land masses is taking place is believed by many, though whether the crustal movement is due mainly to the transfer of molten rock magma from points below the solid crust, the evidence of which is expressed in the volcanic eruptions, whether there is a sufficient transfer of material on the surface due to erosion to cause excessive local strains in the crust because of this transfer of weight, or whether it may be attributed to some

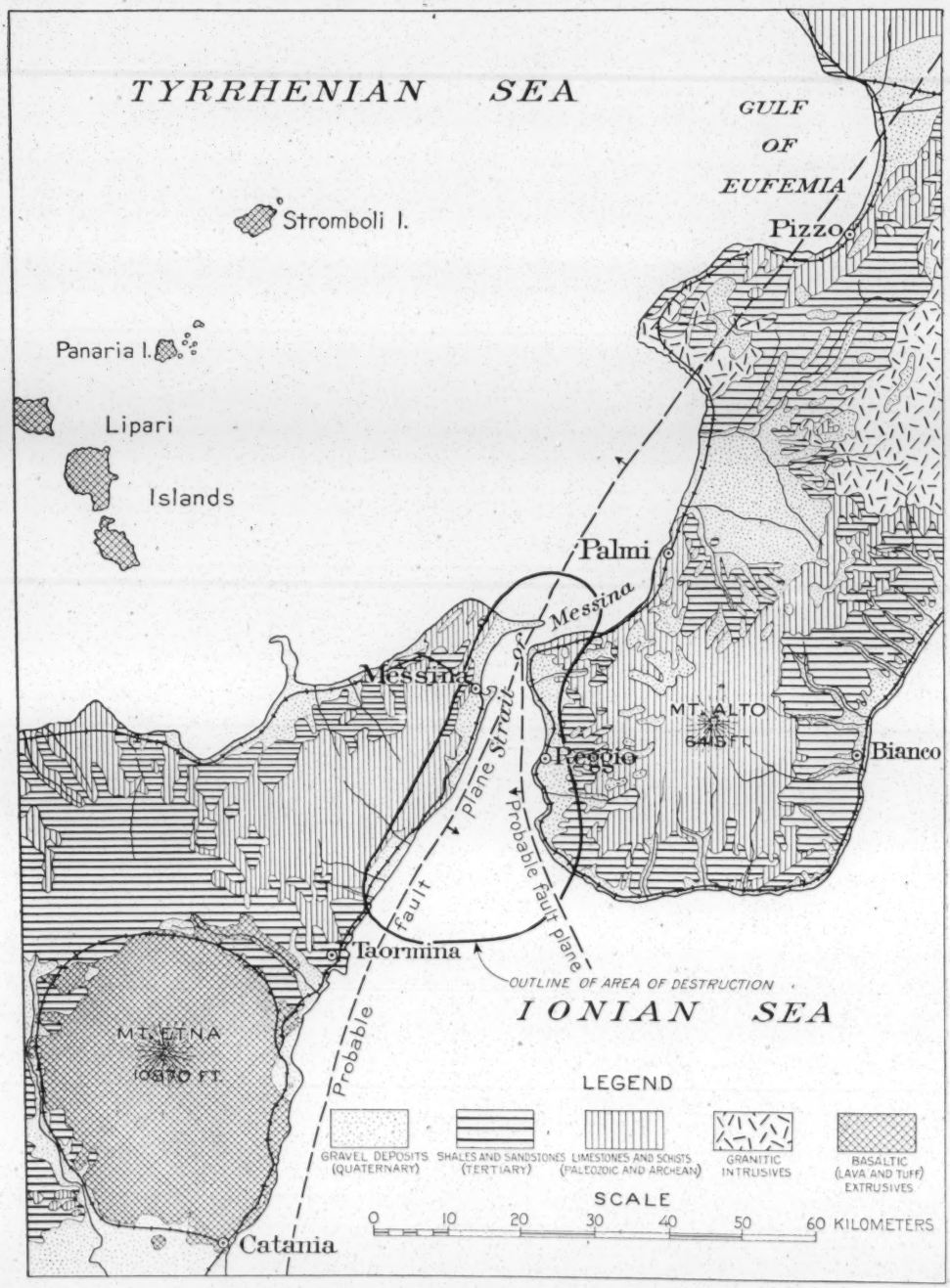


SKETCH SHOWING GRAVEL BEACH DEPOSITS AT REGGIO AND DISPLACEMENTS CAUSED BY LOCAL LAND-SLIPPING

other cause are hypothetical questions. The occurrence of fault planes has been conjectured to be along the bottom of the straits, and, though they have never been seen, there is sufficient geologic and seismographic evidence to believe that they exist, though whether the movement is along one plane or whether it has been taken up by a system of fracture planes or parallel dislocations is not known.

Locally along the shore line of the straits changes occurred, and portions of the quays both in Messina and Reggio were faulted below water level, the local displacements being from 1 to 6 feet. Along the coast are benches of gravel and sand sloping gradually toward the straits and extending a short distance out under tide water, where they end abruptly, and just beyond these the channel has a depth of 1,000 feet, and toward the center it is 2,500 feet below the surface. The earthquake caused a local landslipping of these partially submarine benches, thus producing the displacements observed (see page 393). The greater local sinking at Reggio than at Messina may be attributed to the greater depth of the channel close to the shore, thus causing a greater fall.

If there has been any considerable displacement between the opposite sides of these straits, it must have been a horizontal one, as there has been little or no general vertical change in elevaton of either shore line. This possibility of a horizontal movement of the Sicilian side of the straits to the northwest is suggested



MAP SHOWING THE GEOLOGY IN THE VICINITY OF MESSINA

Compiled from the general geologic map of Italy

PIAZZA MUNICIPALI, SHOWING BUCKLING OF GRANITE BLOCKS CAUSED BY THE SEISMIC WAVE

The city post office is in the background

by the direction of the throw at the time of the earthquake. Most of the towers and chimneys in and about Messina were thrown to the southeast, while in the vicinity of Reggio towers were thrown locally to the north, though on this side of the straits the general direction of the throw was poorly expressed by the structures.

Imagine now local landslides, largely submarine, occurring each side of the straits practically at the same instant; this alone would be sufficient to make the sea recede and cause the tidal wave which followed the earthquake. Theories attributing it to changes in depth of the bottom of the straits must be proven by soundings, and it is doubtful if any perceptible change will be found.

The answers to the questions whether the region may now look for respite or whether it is becoming unfit for human habitation can only be based upon careful consideration of the causes of earthquakes and the history of past earthquakes in this vicinity. That there will be future disasters of this character here is most probable, though it is hoped that the present movement inaugurates a long era of comparative repose.

It is gratifying to know that present studies in seismology are in the direction toward the prediction of place and time of both earthquakes and volcanic eruptions. The malloseismic areas are being outlined, the underlying formations are being studied in detail, past records carefully considered, and thus tracts of special

instability are becoming known. The determination of the time such mallosesmic disturbances will be active within these specific areas is a far greater problem, and though many hypotheses based on rhythmic recurrence, alternation between different parts of a district, precipitation, etc., are being developed, still solution of this vital question, the forecasting of earthquakes, belongs to the indefinite future. Thus the areas of peril may be definitely known, and though the time is indefinite, necessary precautions in the construction of earthquake-proof houses within such areas will insure both life and property against the great losses caused by these destructive forces.*

*The reader is referred to "Earthquake Forecasts," by G. K. Gilbert, in Science, vol. XXIX, No. 734.

THE AMERICAN RED CROSS IN ITALY

By Mabel Boardman

Director of the American Red Cross

BESIDES the Congressional appropriation of $800,000 for aid to the sufferers of the Italian earthquake, the American people have contributed a million dollars through the American Red Cross. This generous and practical expression of our sympathy for the victims of the terrible disaster has been expended in various ways. Knowing that the Italian Red Cross, with its equipment for field hospitals, hospital trains and ships with their personnel, was specially fitted to assist in the care of the great numbers of injured, $320,000 was contributed through Mr Griscom, our Ambassador at Rome, to this sister organization in Italy.

As Mr Bayard Cutting, Jr., the American Consul at Milan, was sent by our government directly to Messina to look after American interests there, he, on request, kindly consented to act as the American Red Cross representative, and $15,000 was transmitted to him to be used for the benefit of any Americans among the sufferers, and for what other immediate purposes he thought best. As only one Italian-American family was in need of assistance, Mr Cutting used much of this fund for the aid of local committees engaged in such relief work as caring for the injured, employing the well, and providing food and clothing for the destitute.

On Mr Griscom's suggestion, $100,000 was cabled him for the "Red Cross relief ship *Bayern*," which, thanks to the energy of Mr Griscom and his American committee at Rome, entered the harbor of Messina just sixty hours after it was chartered at Genoa, under command of the U. S. Naval Attaché at Rome, Commander R. R. Belknap. It flew the Red Cross flag and carried members of the committee, a capable medical and nursing personnel, and a large cargo of food, clothing, and hospital supplies. Going from port to port—Messina, Catania, Reggio, and Palermo—it distributed its life-saving stores.

Of the ship fund, 150,000 lire was carried in money, which proved of great use, particularly in aiding the invaluable work of Miss Davis, of the Woman's Reform School of New York State, who, chancing to be at Syracuse, Sicily, had promptly instituted employment work for the men and women refugees. The former were employed in house-building, shoemaking, and the unskilled labor in road construction, and the women in the making of clothes. Thanks to this initiative, employment stations were also started in Palermo, Red Cross funds being provided from the *Bayern* for this purpose.

To Mr Griscom was also sent $50,000 to aid in the all-important rehabilitation work. For the administration of this

fund the Prime Minister appointed an Italian committee of prominent men and women. By the purchase of tools for laborers, instruments for professional men, small stocks for petty storekeepers, sewing machines for women, many of the unfortunate people can be again placed on a self-supporting basis.

At the request of *The Christian Herald*, which raised the money, $50,000 was forwarded through the Italian Ambassador in Washington to the Queen for the immediate care of widows and babies, and $5,000 contributed by the same generous paper was sent for the relief of Waldensian sufferers in Sicily.

Upon further suggestion from Mr Griscom, after consultation with the Italian government, $250,000 was contributed for the maintenance of an agricultural colony for the care of children left dependents. This institution is to be called "The American Red Cross Orphanage." The American Ambassador at Rome is to be an *ex officio* member of its board. It is to be established in Sicily or Calabria, the government providing the land and the national committee the buildings. The children will be educated as practical agriculturalists by government experts.

BUILDING HOUSES

Some $20,000 more sent to Mr Griscom, together with $17,000, a balance left from the Relief Ship Fund, is being expended as part of our Red Cross work in the rebuilding of one of the ruined villages of Calabria. Between two and three hundred wooden houses are to be constructed from lumber purchased in Naples, and a small hospital is also to be built.

The greatest need today is for shelter. The purchase of materials for over two thousand houses and the chartering of ships for their transportation was the wise use to which $500,000 of the Congressional appropriation was applied. The Red Cross also expended $107,000 for some six hundred houses and the chartering of a ship for their transportation.

The funds for the building of both the American Red Cross houses and those given by our government are also being provided by our Red Cross, $48,000 having been forwarded for that purpose. The National Director of the American Red Cross having been sent to Italy, $14,000 has been placed to his credit in Rome for such relief measures as he may advise after consultation with Mr Griscom. It is possible that this amount, with a further appropriation, may be required for the construction of small brick ovens for the houses, as the use of stoves among the poorer classes is unknown in southern Italy.

The American houses are being built mainly at Messina and Reggio. Each house is 20 by 16 feet, and, unlike the long structures built by some of the other countries, stands by itself and is clapboarded. Some of those already built have been placed in groups of twelve around rectangles, five on the sides and one at each end, the Italian government donating the land.

The total amount so far expended through the American Red Cross for the Italian relief work amounts to $976,000. Our people have been glad to help their unfortunate fellow-men in southern Italy, and from no portion of our land has the response been so generous as from California, so lately itself the scene of a great disaster.

SHACKLETON'S FARTHEST SOUTH

ALL records for South Polar exploration have been surpassed by Lieut. E. H. Shackleton, R. N., who is now returning to England after fourteen months spent within the Antarctic Circle. Shackleton, on January 9, 1909, gained a point within 111 miles from the South Geographical Pole, while another of his parties actually reached the South Magnetic Pole on January 16, 1909, according to press dispatches from New Zealand. He has shown that the Geographical Pole is situated on a high plateau about 10,000 feet above sealevel, and that the remarkable floating ice-barrier stretching for 500 miles between King William VII Land and Victoria Land, and justly called one of the wonders of the world, does not apparently reach beyond the eighty-third degree. But to Americans his most interesting discovery is new land and mountain ranges extending from South Victoria Land, which once more confirms the great discoveries of the American Wilkes, made nearly seventy years ago. (See page 402).

Lieutenant Shackleton, with a party of about 15 men, dogs, Siberian ponies, motor cars, and other equipment, was landed from the *Nimrod* in January, 1908, at Cape Royds, near the base of the smoking volcano, Mount Erebus. Here he made his headquarters for the year at the same base used by the previous British Antarctic Expedition (1901-1904), led by Captain Scott, whose splendid achievements were described in this Magazine in February, 1907. The motor cars proved apparently of little value during the ensuing year's work, owing to the crevasses in the ice, but the Siberian ponies showed remarkable endurance of cold and great pulling power.

Campaigning against the Pole in some respects is easier in the south than in the north. The weather is much harsher and more boisterous in the south, but the working season is longer. The North Pole is surrounded by an ice-covered ocean, which must be crossed in spring before the ice breaks apart under the summer sun. The South Pole, on the other hand, is situated on a great ice plateau, which may be traversed during almost the entire period of daylight. Thus, while Peary must complete his dash from the most northern land to the Pole and back in a period of about sixty days, the South Polar explorer has more than one hundred and twenty days at his disposal.

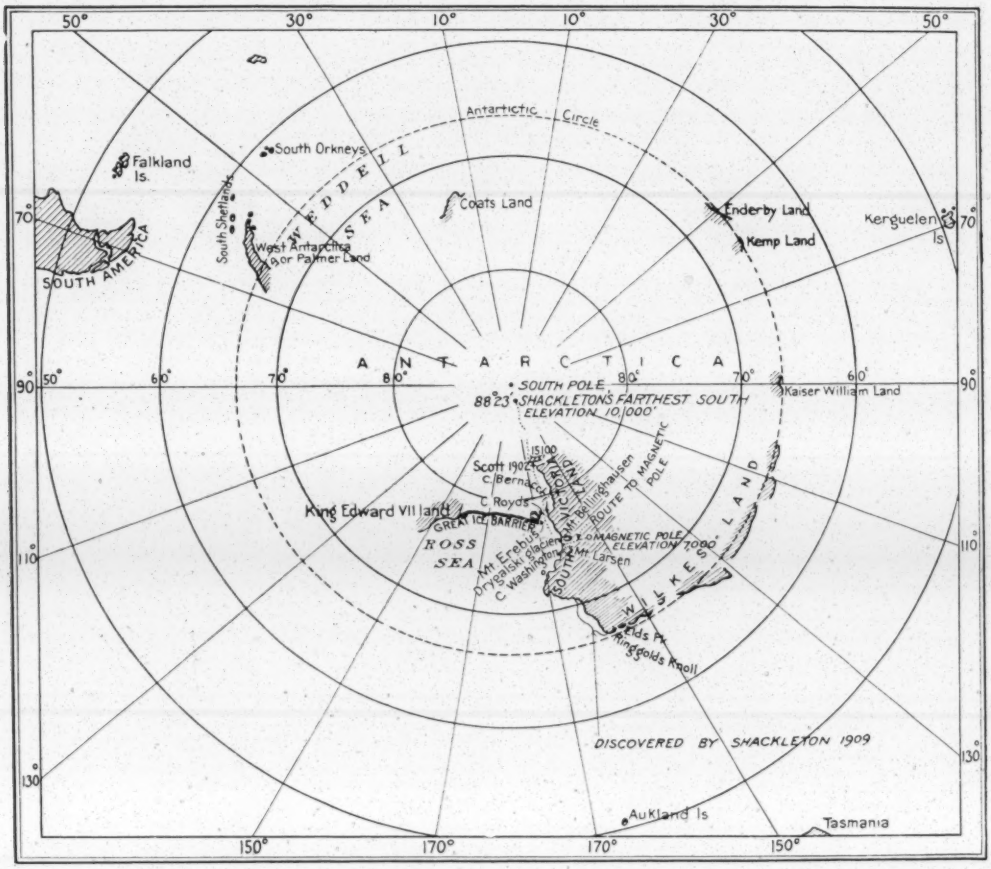
Lieutenant Shackleton not only won the record for farthest south, but he has reached a point nearer the South Pole than any explorer has been able to approach to the North Pole. The story of his year's work, as given in the cable dispatches from New Zealand, follows:

The southern party—Adams, Marshall, Wild, and I—with four ponies and a supporting party, consisting of Sir Philip Brocklehurst and Messrs. Joyce, Marson, Armytage, and Priestly, left Cape Royds on October 29, 1908, with ninety-one days' provisions. The supporting party returned on November 7.

Owing to the bad light among the ice crevasses, Adams and a pony were nearly lost. We reached on November 13 the depot laid out in September in latitude 79° 36′, longitude 168° east. We took on a pony the maize and provisions previously left there and commenced reducing our daily rations.

We traveled south along meridian 168 over a varying surface, high ridges and mounds of snow alternating with soft snow. The ponies often sank to their bellies. In latitude 81° 4′ we shot the pony Chinaman and made a depot of oil, biscuit, and pony meat. The remainder of the pony meat we took on to eke out our dried rations.

On November 26 we reached the *Discovery* expedition's southernmost latitude. The surface was now extremely soft, with large undulations. The ponies were attacked with snow blindness. On November 28 the pony Grisi was shot. We made a depot in latitude 82° 45′, longitude 170°. The pony Quan was shot on November 30. We had now traveled 400 miles across the ice barrier.



OUTLINE MAP OF SOUTH POLAR REGIONS

Steering south and southeast, we were now approaching a high range of new mountains trending to the southeast. We found on December 2 the barrier influenced by great pressure and the ridges of snow and ice turned into land. We discovered a glacier 120 miles long and approximately 40 miles wide, running in a south and southwesterly direction.

ASCENT TO THE CONTINENTAL PLATEAU

We started on December 5 to ascend the glacier at latitude 83° 33′, longitude 172°. The glacier was badly crevassed as the result of huge pressure. The surface on December 6 was so crevassed that it took the whole day to fight our way 600 yards.

On December 7 the pony Socks, breaking through a snow lid, disappeared in a crevasse of unknown depth. The swingletree snapping, we saved Wild and the sledge, which was damaged. The party was now hauling a weight of 250 pounds per man.

The clouds disappearing on December 8, we discovered new mountain ranges trending south and southwest. Moving up the glacier over the treacherous snow covering the crevasses, we frequently fell through, but were saved by our harness and were pulled out with the Alpine rope. A second sledge was badly damaged by knife-edged crevasses.

Similar conditions obtained on our way up the glacier from December 18, when we reached an altitude of 6,800 feet. In latitude 85° 10′ we made a depot and left everything there but our food, instruments, and camp equipment, and reduced rations to twenty ounces per man daily.

We reached on December 26 a plateau, after crossing ice falls, at an altitude of 9,000 feet, thence rising gradually in long ridges to 10,500 feet.

Finishing the relay work, we discarded our second sledge. There was a constant southerly blizzard, wind, and drifting snow, with the temperature ranging from 37 to 70 degrees of frost. We lost sight of the new mountains on December 27.

Finding the party weakening from the effects of the shortage of food and rarefied air and cold, I decided to risk making a depot on the plateau. We proceeded on January 4 with one tent, utilizing the poles of the second tent for guiding marks for our return. The surface became soft and the blizzard continued.

WITHIN 111 MILES OF THE POLE

For sixty hours during January 7, 8, and 9 the blizzard raged, with 72° of frost and the wind blowing seventy miles an hour. It was impossible to move. Members of the party were frequently frostbitten in their sleeping bags. We left camp on January 9 and reached latitude 88° 23′, longitude 162°.

This is the most southerly point ever reached. Here we hoisted the Union Jack presented to us by the Queen. No mountains were visible. We saw a plain stretching to the south.

We returned to pick up our depot on the plateau, guided by our outward tracks, for the flags attached to the tent poles had been blown away. Less violent blizzards blowing at our backs helped us to travel from twenty to twenty-nine miles daily. We reached the upper glacier depot on January 19.

The snow had been blown from the glacier surface, leaving slippery, blue ice. The descent was slow work in the heavy gale. The sledge was lowered by stages by the Alpine rope.

On the morning of January 26 our food was finished. It was slow going. Sixteen miles were covered in twenty-two hours' march. The snow was two feet deep, concealing the crevasses. We reached the lower glacier depot in latitude 83° 45′ on the afternoon of January 27. There we obtained food and, proceeding, reached the Grisi depot, named after the dead pony, on February 2.

There was no food remaining. Wild was suffering from dysentery, the effect of horse meat. The entire party were prostrated by dysentery on February 4 and were unable to move. The dysentery continued eight days, but helped by strong southerly blizzards we reached Chinaman depot on February 13. The food had again run out.

The blizzards continued, with 50° of frost. We discarded everything except our camp outfit and geological specimens and on February 20 reached the next depot, all our food being finished.

Helped by the southerly blizzard, which was accompanied by 67° of frost, we reached on February 23 a depot on Minna Bluff, which had been laid by the Joyce party in January. Here we received news from the ship. Marshall had a relapse and return of dysentery.

We made a forced march of twenty-four miles on February 26. Marshall was suffering greatly. On February 27 Marshall was unable to march. I left him in camp in charge of Adams, while Wild and I made a forced march to the ship for relief. I returned on March 1 with a relief party, and all reached the ship at Hut Point on March 4 in a blizzard.

The total distance of the journey, including relays, was 1,708 statute miles. The time occupied was 126 days. The main result is a good geological collection. We found coal measures in limestone. We also made a complete meteorological record. We discovered eight distinct mountain ranges and more than a hundred mountains. We surveyed and photographed many glaciers and found signs of former greater glaciation.

The Geographical South Pole is doubtless situated on a plateau, from 10,000 to 11,000 feet above the sea level. The new mountains' altitudes range from 3,000 to 12,000 feet approximately. The violent blizzards in latitude 88° show that if the "polar calm" exists it must be in a small area or is not coincident with the Geographic Pole.

LOCATING THE MAGNETIC POLE

The northern party, consisting of Douglas, Marson, Rackay, and Davis, left Cape Royds for the Magnetic Pole on October 5, 1908. We picked up the depot left by the motor car fifteen miles out. The party hauled two sledges by relays, the total weight being 600 pounds per man, with provisions for ninety-three days.

The thawing sea ice, compacted of brush and crushed pack, made progress laborious and slow. The sea ice south of the Drygalski Glacier was beginning to break up. The first attempt to cross to the glacier failed, owing to numerous deep chasms. We crossed further east on December 6, and followed a difficult route over crevassed pressure ridges.

We attempted the glacier between the mountains Nansen and Larsen. After sledging among high pressure ridges, where the sledges and party were often nearly lost in the crevasses, we abandoned that route. A blizzard then covered the glacier deeply drifted with snow and the sledges were extricated with difficulty.

Subsequently violent blizzards removing the loose snow enabled the party to ascend the steep slope of a branch glacier to the main glacier between the mountains Larsen and Bellinghausen. Thence there was fair traveling to an inland plateau at an altitude of over 7,000 feet. Strong southerly winds, 50° of frost, and shortened rations made traveling trying.

The party reached the Magnetic Pole, 260 statute miles northwest of the Drygalski depot, on January 16, and hoisted the Union Jack. The position of the Pole was determined by Marson with a Lloyd-reak dip circle as in the vicinity of latitude 72° 25′, longitude 15° 4′ east.

The duration of the journey was 122 days. We traveled, including relays, 1,260 statute miles. The coast was triangulated by Marson with a theodolite from McMurdo to the Drygalski Glacier. There are also geological, magnetic, and meteorological results. Minerals, apparently vanadium and widely spread monastite, were found.

In March, 1908, a party headed by Lieut. Adams, left Cape Royds to ascend Erebus, the great Antarctic volcano. They climbed with a sledge to an altitude of 5,500 feet, thence carrying their equipment on their backs. They reached an altitude of 9,500 feet on March 7. The temperature was 50° below freezing. Then a violent blizzard raged for thirty hours. Resuming the ascent on March 9, they reached the old crater of the volcano at over 11,000 feet.

Unique fumaroles or smokeholes were found. The old crater was chiefly filled with large felspar crystals, pumice and sulphur. Sir Philip Brocklehurst had both feet badly frostbitten. One toe was subsequently amputated. The summit was reached on March 10. The active crater is half a mile in diameter and 800 feet deep. It was ejecting vast volumes of steam and sulphurous gas to a height of 2,000 feet.

WILKE'S DISCOVERIES CONFIRMED

The *Nimrod* on the voyage to pick up the expedition reached the ice sheet off Mt. Erebus on January 3. Various parties of the expedition were taken on board at different points, Lieut. Shackleton's being the last, on March 4.

On the voyage homeward in the *Nimrod* from latitude 69° 48′, longitude 166° 11′, they discovered a new range of coast mountains trending first southwest and then west. The approximate altitude of these mountains is from 5,000 to 7,000 feet. They are mostly tabular and form part of an apparently deeply eroded plateau. This discovery by Shackleton is an extension of South Victoria Land westward to about 70° 30′ south, 162° east, which appears to render certain its continuity with Wilkes Land.

Gen. A. W. Greely, in his admirable "Hand-book of Polar Discoveries," successfully demonstrates the general correctness of Wilkes' discoveries, which were acrimoniously disputed by Captain Ross, R. N., whose own Parry Mountains have been proved non-existent. The very high land seen by Wilkes, when he discovered the Antarctic continent, on

January 19, 1840, is only separated from Shackleton's discovery by about 250 miles.

The ends of the globe are as far apart in character as in distance. General Greely, in his "Hand-book of Polar Discoveries," gives the following interesting comparison of the polar areas:

The lands within the Arctic Circle are not alone contiguous to powerful and enterprising nations, but are also so favored by climate and soil as to present suitable conditions for animal and plant life. Indeed, Arctic Europe, Asia, and America present large habitable districts, where human activities afford life environments not altogether harsh or unattractive. In addition the northern seas, filled with abundant life, furnish subsistence and wealth to thousands of daring men who yearly seek their accessible waters.

At the other Pole of the world we find the Antarctic region to be the true land of desolation—forbidding, inaccessible, and uninhabitable. Its northern confines and surroundings are largely oceanic, so that freezing temperatures, fierce snow-blizzards, and other winter conditions are not unusual in midsummer. While in high latitude near the South Pole there are extended lands and doubtless a continent, yet these are sterile areas, overlaid with ice-coverings of vast extent and enormous thickness.

It is doubtful if one per centum of Antarctic lands is ever ice-free, so that ordinary forms of land-life are absolutely wanting. Not only are human inhabitants unknown south of Cape Horn, more than 2,300 miles from the Pole, but, except sea forms, within the circle animal life and vegetable life are practically absent save a few low forms of hardy lichens and mosses. No plant life gladdens the eye, and even the hum of insects is unheard, the terrestrial fauna consisting of wingless insects. Sea life is more abundant than in any other ocean, the higher forms being whales, seals, and birds—skuas, penguins, and petrels—but owing to distance and danger their pursuit and capture are no longer remunerative.

On the Canal Zone. By Thomas Graham Grier. With illustrations and map. 6 x 9 inches. Chicago: Wagner & Hanson. $1.00.

The author, a well-known electrical engineer of Chicago, has brought back from Panama a quantity of interesting information and photographs and compiled them into an attractive book. The trip to the Isthmus is in the form of a diary, and the rest of the book is divided into chapters, giving accounts of the cities of the zone, the canal, the locks, and the labor question. Much interesting data regarding the commissary, sanitation, amusements, etc., is given, and Mr Grier has warm words of praise for the way the work of the canal is being pushed forward and the improvements that have come about since the American occupation of the zone, and concludes with the following strong endorsement: "The force at work is efficient and energetic, having behind it the spirit and the brains of men who are able and intelligent."

Among the Wild Tribes of the Afghan Frontiers. By T. L. Pennell, M. D. Pp. 324, 6½ x 9½ inches. Illustrated. Maps and glossary. Philadelphia: J. B. Lippincott Company. $3.50 *net.*

This book is an unpretending record of sixteen years' good work by an officer—a medical missionary—in charge of a medical station at Bannu, on the northwest frontier of India. The author throws many interesting side-lights on the domestic and social, as well as on the moral and religious aspects of the lives and characters of the tribesmen. Throughout Dr Pennell writes with great simplicity and sincerity; he is careful to confine himself mainly to what he has himself heard and seen; and, above all, he shows that he possesses, in a quite exceptional degree, that insight into the minds of the natives which is the first qualification of any real power of helping and benefiting them. It is altogether a work of singular charm and value, particularly to all those who are interested in the present and future well-being of the native races.

A British Officer in the Balkans. By Major Percy Henderson. Pp. 304; 6½ x 9½ inches. Illustrated. Maps and index. Philadelphia: J. B. Lippincott Company. $3.50 *net.*

Major Percy Henderson has written an interesting record of a lengthy tour through Dalmatia, Montenegro, and Turkey; in Austria, Magyrland, Bosnia, and Herzegovina. The author's account is not that of a hurried traveler, but is the evident result of careful and appreciative observation. He tells of a part of eastern Europe as yet unspoiled by tips or exorbitant hotel charges; of a land possessing all the variety of scenery of Norway, the coloring of Italy, with the added glamour of the Orient. The book is illustrated with many excellent photographs, which were taken by Mrs. Henderson. J. O. L.

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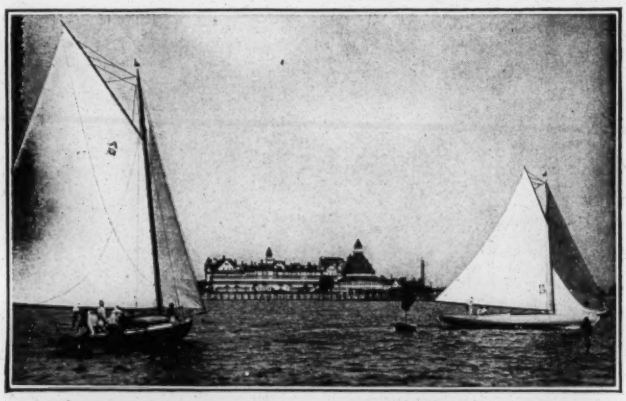

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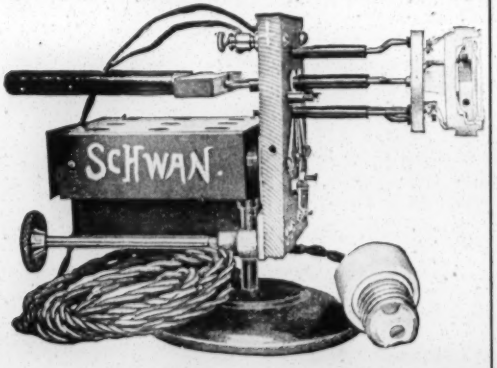

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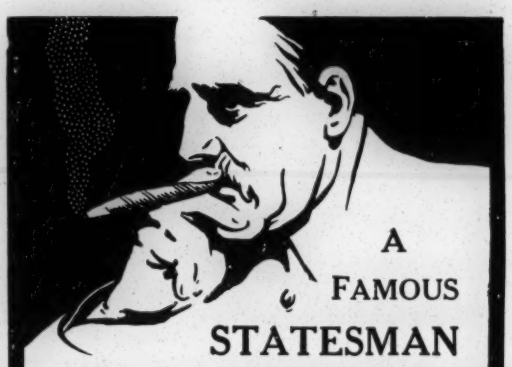

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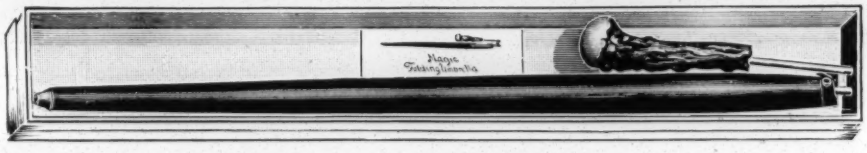

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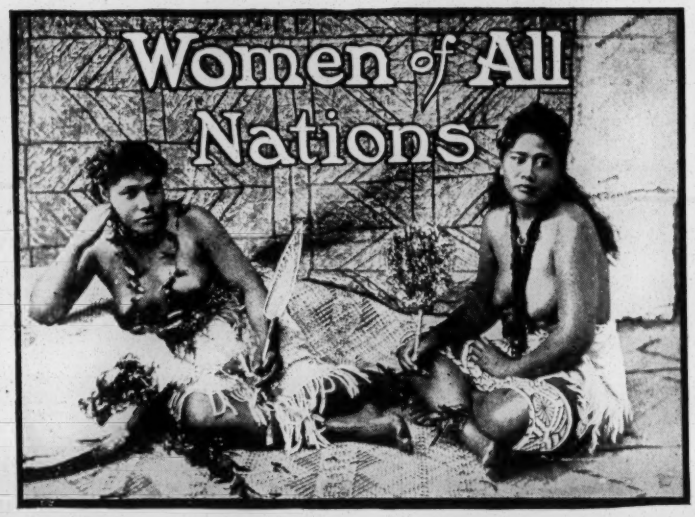

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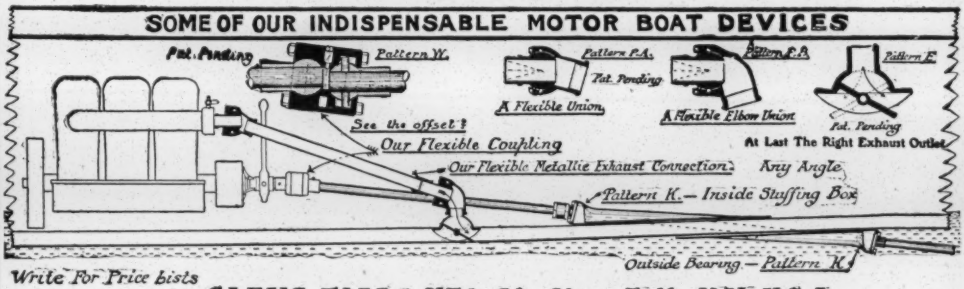

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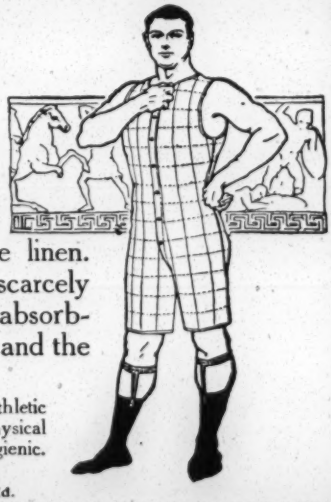

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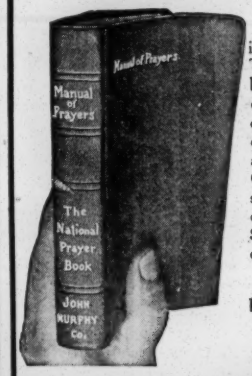

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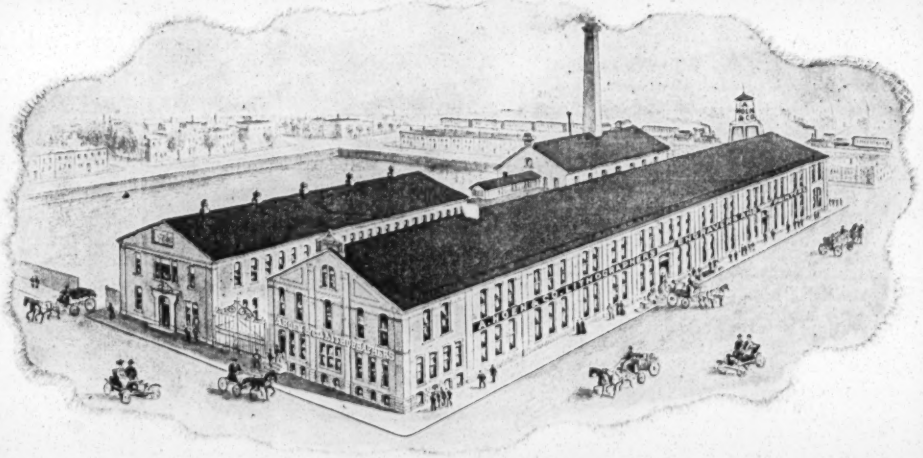

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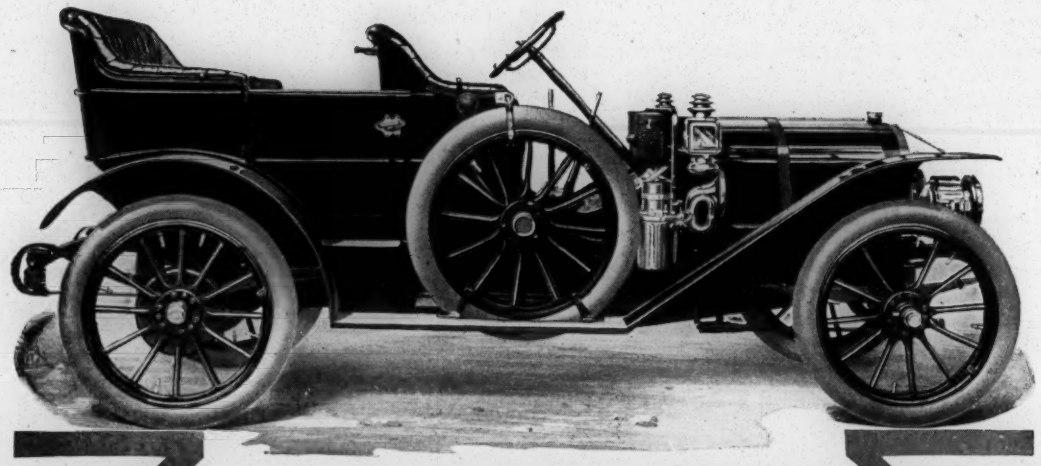

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